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Original Articles

THE LATE FRANCIS MILBURN HOWLETT, B.A., F.E.S.

THE death of Francis Milburn Howlett at Mussoorie on August 20th was felt as a keen personal loss by those who knew him best, and leaves a gap in the ranks of scientific workers in India that can hardly be filled.

He was born at Wymondham in Norfolk in January 1877, and graduated with Honours from Christ's College, Cambridge, in 1899, and was thus 30 years of age in 1907 when he joined the Indian Agricultural Department, after working for some time as Professor of Biology at the Muir Central College, Allahabad.

His appointment as Second Imperial Entomologist at Pusa brought him into contact with H. Maxwell-Lefroy to whom he always evinced a characteristic loyalty. At Pusa he specialized on "flies," and prepared the sections on Mallophaga, Diptera, Cimicidae and Anoplura for Lefroy's book "Indian Insect Life." He was also no mean artist, and the high standard of illustrations attained in its earlier days by the "Agricultural Journal of India" was due largely to his oft-sought advice and criticism, while his humorous sketches will long be remembered by his contemporaries at Pusa.

Besides contributions to departmental publications, he published a number of papers in scientific journals the subjects of which will give some idea of the special trend of his entomological work. They include :—

The Influence of Temperature upon the biting of Mosquitoes.

(*Parasitology*, December 1910.)

The Effect of Oil of Citronella on two species of *Dacus*.
(*Trans. Ent. Soc.*, October 1912.)

The Natural Host of *Phlebotomus minutus*, and
Insect Life-Histories and Parasitism. (Both in the *Indian
Journal of Medical Research*, Vol. I, No. 1, July 1913.)

A Trap for Thrips. (*Jour. Econ. Biol.*, London, March 1914.)

Chemical Reactions of Fruit Flies. (*Bull. Ento. Research*,
London, December 1915.)

He was elected President of the Zoological Section of the Sixth Indian Science Congress held in Bombay in January 1919, and gave an address on "Tactics against Insects."

At the time of his death he had completed the manuscript of a book on "The Control of Harmful Insects" which he intended to publish shortly.

His services were utilized by the Military Department in India in connection with the control of mosquitoes and of the flies which convey Surra in camels, and at Home in dealing with the disease-carrying insects that added to the danger of the war zones, including lice and sandflies.

Of his work in the special line that he had selected, Dr. Tragardh wrote in the "Bulletin of Entomological Research": "In my opinion, the investigations of Verschaffelt, Dewitz, and Howlett, if regarded in the light of the researches of physiologists into chemotropism, are of an importance which cannot be overestimated, and will guide practical entomology into new lines. Intimate co-operation between vegetable chemistry and entomology in the question will surely provide us with good weapons in our fight with many insects against which we are at present absolutely helpless."

It is worth mentioning here two very interesting discoveries which he made.

One was with regard to fleas. In a course of experiments he discovered that fleas have an extreme dislike for wet grass, and that when forced to choose between sitting on wet grass, and on grass which has been sprinkled with kerosine oil, all the fleas would leave the wet grass, and crowd on to the grass covered with kerosine oil. This experiment has an obvious bearing on questions concerning the

PLATE XXXIV.



The late FRANCIS MILBURN HOWLETT, B. A., F. E. S.,
Imperial Pathological Entomologist.

diffusion of plague, and helps to explain why plague ceases every year at the beginning of the rains, and does not start again until after the rains, either in the cold or hot weather, and also helps to explain why plague has never got a foothold in Bengal and other water-logged areas.

Another discovery was that certain kinds of mosquito larvæ could live for comparatively long periods in quite dry earth. Howlett's method of announcing his discovery to the scientific world was characteristic of the man. All he did was to send a tube containing some dust to a scientific exhibition, with a short note requesting that on arrival some water might be poured into the tube, which should then be covered with gauze. In due course mosquitoes emerged, and the success of the experiment acknowledged. Both experiments require and deserve verification and further investigation.

Howlett was a man of almost childlike simplicity and originality of outlook, and with many interests. He was the most delightful of companions and the truest of friends. He had the faults as well as the merits of the artistic temperament. Keenly alive to the possibilities of a new idea, old and half worked out schemes were apt to be jostled aside and displaced in the ardour of some new investigation. He was a born schoolmaster, delighted in teaching, and could make all subjects interesting, and had the gift of implanting in his disciples some of his own enthusiasm.

He was a combative apostle of Pure Research, and his disappearance from the ranks of scientists of this order will be a serious blow to the cause.

SOME COMMON INDIAN BIRDS.

No. 6. THE WHITE WAGTAIL (*MOTACILLA ALBA*).

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist ;

AND

C. M. INGLIS, M.B.O.U., F.Z.S.

INDIA has many birds which visit the plains as winter tourists only, passing the summer months either in the hills or in "the back of beyond" far to the north of the mighty Himalayas. Every one is familiar with the fact that ducks, for example, migrate in this way but it may be news to some of our readers that most of our common Wagtails also act in this manner, visiting India only in the cold weather and passing the summer in Northern Asia. About a dozen different species are found in India but only one (*Motacilla maderaspatensis*), a black species with a conspicuous white eyebrow, looking not unlike a magpie-robin but never carrying the tail erected, is a permanent resident. All are very similar in general build, being slenderly built, dainty-looking birds, mostly coloured in mixtures of black, white and grey, occasionally yellowish or greenish, their delicate slimness harmonizing well with their lightness of gait as they run with great speed after their quarry, never hopping but sometimes making little sallies into the air, and constantly wagging their tails whose outer feathers are always white and conspicuous during flight; whence their popular name. Then, as Cunningham has well remarked, they are so alluringly tame, merely running on in front of one and expostulating at being disturbed;

and, if persistently followed along a narrow path, making off on a brief, undulating flight to pitch anew a little way ahead in a way that gives one the fullest opportunity of becoming familiar with them. They are so tame that they often come into verandahs of bungalows and pick up insects off the floor. The migrant species usually arrive in India during September and remain with us until the end of the cold weather, the White Wagtail leaving Bihar before the end of April.

Wagtails feed mostly on small insects, chiefly flies, small beetles, ants and caterpillars, but occasionally pick up seeds also. The insects eaten are not of any beneficial kinds and in many cases are injurious to crops, and therefore these birds as a whole must be reckoned amongst the farmer's friends. It is a pity that most of them are absent from India during the Rains, when insect life is so abundant. The particular species which we have selected as a representative of this group is the White Wagtail (*Motacilla alba*), which Dewar briefly describes as, general colour of plumage grey; face, chin, and throat white, back of head and nape black; a black patch on the breast, the remainder of lower plumage white; the wings white with much black on them: the middle tail-feathers black, the outer ones white. Our plate (Frontispiece) gives a good general idea of its appearance. It has a very pleasant note. It is found throughout most parts of India during the winter months but does not occur in Southern India nor South of Moulmein in Burma. The Masked Wagtail (*M. personata*) is by some authors regarded as a distinct species, but by others as a form of *M. alba*, from which it differs by the ear-coverts and sides of neck being always black, whereas in *M. alba* these parts are always whitewashed. The distribution of *M. personata* much resembles that of *M. alba*, but it does not occur east of Calcutta and is a constant resident, and breeds, in North-West India.

The White Wagtail is a regular visitor to England during its time of migration from the Continent of Europe and breeds in England at times and has been known to pair there with the Pied Wagtail (*M. lugubris*), a species which does not occur in India.

Its nest has been found there in such odd places as in a Sand Martin's burrow, in the middle of a strawberry bed, and amongst a Virginian creeper growing over trellis-work. The eggs are bluish-white, speckled with black. So far as we know, it never breeds in India, and Hume in his *Nests and Eggs of Indian Birds* omits the White Wagtail altogether but mentions the Masked Wagtail, *M. personata*, which is perhaps a subspecies of the White Wagtail, as breeding in Afghanistan in May and June, the nest being usually placed in holes, under large stones, in or near beds of rivers.

The habits of the White Wagtail resemble those of the Pied. Dr. A. G. Butler gives some interesting notes on the latter species, in the course of which he says, "their power of turning in the air is astounding; few insects, however eccentric their flight, can hope to escape them. If a Wagtail is on the ground and it sees an insect flying towards it, instead of starting madly forward to meet its prey, it excitedly watches all the insect's movements and suddenly (when the latter is almost overhead) the agile bird rises with a rapid spiral movement, which looks almost like a somersault, the snap of its mandibles is heard, and all is over." He also writes, "even when caught wild, most examples of *Motacilla* soon become tame if kindly treated; they are easy to feed, living for years upon crumbled household bread, yolk of egg and ants' cocoons, moistened (either by the addition of a little water or mashed potato) and a few insects, their larvæ or spiders from time to time."

As most species of Wagtails are not permanent residents and do not breed in India, they have not received legislative protection in most Provinces, except in Bengal where they are protected throughout the year and in Burma where they are protected in reserved forests from being hunted, shot, snared or trapped for purposes of trade.

THE EGYPTIAN COTTON PROBLEM.

A REPORT TO THE EGYPTIAN GOVERNMENT.

BY

H. MARTIN LEAKE, M.A., F.L.S.,
Director of Agriculture, United Provinces.

(Continued from Vol. XV. Pt. V, p. 591.)

III.

IN the above review I have attempted to bring into prominence the salient features of the Egyptian cotton problem. The subject is a wide one and touches at many points on several of the commonly accepted divisions of science. I may now attempt to collect these into some systematic scheme which will serve as a foundation on which to build the organization which will be required to attack the problem successfully and as an indication of the staff and equipment which will be required for this attack. It will, perhaps, be objected that no mention has been made of the commercial aspect which is concerned with the disposal of the crop. While recognizing the importance of this aspect to the country generally, I do not hold that it falls within the sphere of a Ministry of Agriculture as such. The primary work of that Ministry is completed when it has pointed the way to obtain the maximum yield of pure cottons, and it is only directly concerned with the subsequent disposal of the produce in as far as it may be necessary to protect the seed supply required for sowing and to ensure for this a condition of purity. This is, however, an important point—the end term of the series which commences with the single plant of the plant-breeder. Every link of the chain forming that series must be adequately guarded

and the last, no less than the first, will require consideration if the field of investigation is to be covered.

We can recognize in the above review four primary lines of investigation to which we apply the terms Economic, Botanical, Agricultural, and Commercial, and to these we may add certain collateral lines. These may, in like manner, be termed Entomological, Mycological, Bacteriological, and Physical. But let me not be misunderstood in this matter; the difference between the primary and collateral lines, as here defined, is not one of relative practical importance. The former are concerned directly with the plant and its produce, the latter with the subsidiary conditions of growth which make cultivation an economic proposition. The two groups are truly complementary, for it is as useless to produce a potentially valuable plant, if the conditions of growth do not permit it to develop its inherent qualities, as it is to control those conditions in the absence of a plant capable of reaping the full benefit of that control.

PRIMARY LINES.

I. Economic.

The essential economic considerations have been seen to include diversity of classes accompanied by uniformity within the class itself. That diversity is required to meet the needs of different sections of the trade: the demand for any particular class is, thus, to some extent, independent of the demand for other classes and the magnitude of the demand depends on the relative importance of the section mainly concerned in working up that class. A knowledge of the normal relative requirement of the different classes and the normal relative price of these, under conditions when supply and demand about balance, is of primary importance.

In view of the probable early disappearance of Egypt's monopolistic position with regard to certain classes of cotton, accurate information is also required of the developments taking place in all countries likely to encroach on that monopoly. Especial care requires to be taken in the collection of statistical information on both these heads.

II. Botanical.

(1) *Selection.* Selection requires to be conducted on two independent lines and work along both of these should be conducted simultaneously. In the first place, and this forms the most important immediate need, selection should be directed to isolating, and maintaining the purity of races yielding the standard classes of the present day. Such selection forms the basis of any scheme which aims at eliminating 'degeneration' which, in its ultimate form, is interpreted as due to an inherent plant character giving to the type a limited span of life.

Secondly, it must be directed to the discovery and subsequent isolation of new, and hitherto unrecognized, types, whether the novelty affects the quality of the cotton or the behaviour of the plant in the field. It will cover the search for such plants as develop improved lint, a higher ginning percent., a vigorous habit, accompanied by high yield or an early maturation.

(2) *Hybridization.* The aim of such work is, ultimately, identical with that of the latter form of selection. Here, however, the method is directed. But more than this is involved. We are still ignorant of the factors controlling many of even the more obvious plant characters and there is much preliminary work to be done in this direction.

(3) *Physiology.* Physiological investigation will bear on the general problem at several points. At each stage of its history the plant is in direct response to its environment and growth will be controlled by one or other of the factors composing that environment. In its broadest outline physiological investigation will be directed to determining the limiting factors throughout. In the more particular aspect it will be directed to determining the effect of root interference, the causes of bud and fruit shedding, and the effect of such factors as water-supply on quality of lint.

III. Agricultural.

In the direct sequence, which we have termed, primary, agricultural investigation will carry on the tests of the pure races a stage further and will require facilities for working up a seed supply

of such as successfully pass these tests. Such tests must include not merely comparative trials in one area—for, as we have seen, not the least important aim will be the demarcation of type tracts—but in several areas. Trial grounds will thus be required in each well-defined tract. The working up of a seed supply, involving, as it does, a different set of conditions, and one which will effectively maintain purity, requires separate treatment.

Secondly, provision must be made for subsidiary lines of agricultural investigation, cultural and manurial experiments, and experiments on the water requirements of the field crop. Such investigations are linked, on the one hand, with the physiological work already referred to and, on the other, with the general agricultural problems of the country.

IV. Commercial.

I apply this term in the strictly limited sense defined above. The Agricultural Section can, at the most, produce what constitutes a mere fraction of the seed required for sowing, and purity will not be maintained without some organization to control the crop and to prevent admixture followed by degeneration, after the seed passes beyond direct Ministerial control.

COLLATERAL LINES.*

V. Entomological.

This section of the Ministry is the most highly organized of any at the present time. The subject, too, lies outside the scope of this Report. Reference is made to this line of investigation here merely with the object of indicating that I have not overlooked the

* A certain amount of criticism has been directed against the omission of any reference to chemistry in the list of subjects here enumerated. I think, however, it will be clear that such omission implies no disparagement of the work of the chemist. It must be remembered that I am not concerned with the activities of the Ministry in their entirety but merely with those activities as they concern the cotton problem. The centre of gravity is, thus, shifted, and my enumeration extends beyond those subjects which directly bear on that problem only to a degree sufficient to indicate how my proposals dovetail into the general organization. The subjects are necessarily dealt with incompletely and in a somewhat different order from that in which they would occur were a review of the entire activities of the Ministry under consideration.

subject and that I recognize that any proposals that I am led to make would be of little advantage did they not fit into the scheme as a whole.

VI. Mycological.

From the aspect of the cotton crop, pure and simple, there appears to be small field for mycological work though its importance may develop at any moment. From the point of view of the general activities of the Ministry as a whole there is, especially in relation to horticulture, considerable scope for mycological investigation.

VII. Bacteriological.

Such investigation is concerned with agriculture generally, and is concerned with the subject of cotton merely in as far as that forms one, although the most important, of the crops grown. Little work has been done on bacterial action in the soils of Egypt. The field is large, important and practically unexplored; there can be little doubt that such action is of considerable magnitude and, if controlled, capable of exerting considerable influence on crop development. On the one hand, the study connects up with purely agricultural investigation at such points as manurial and cultural experiment and, on the other, with the physical investigations on soil moisture, its movement and control.

VIII. Physical.

The most important line of physical investigation is, without doubt, that which concerns the relation between the level of the subsoil water (water table) and the rise of the Nile, whether that relation be direct or indirect through the canal system. As such, the subject is closely connected with the irrigation system. Considerable scope for investigation lies also in the direction of determining the permeability of soils of different character and the rate of surface tension flow through these. I am tempted to think that, by a control of such flow through cultural means, irrigation could be much reduced in tracts in which the presence of salts is not marked. This line of investigation is, thus, intimately connected with the purely agricultural cultural experiments.

IV.

I have briefly outlined eight lines of investigation using as a basis the commonly accepted divisions of science. These cover the field presented by the cotton problem of Egypt. It will be convenient if, before I proceed further and enquire in greater detail into the requirements both as regards equipment and organization if these investigations are to be carried out in an efficient manner, I outline the course that will be followed in the development of any particular race which it is desired to develop through the experimental, to the practical, stage. Such development concerns those sections which I have denoted primary. The close interrelation that exists between these four sections and the necessity for full continuity from one stage to the next, a continuity which organization must recognize and allow for, will thus become apparent.

In its simplest terms, then, the work of the Botanical Section will consist of the isolation by means of single plant cultures--and for the present purpose, these cultures may arise as direct selections or as the result of hybridization--of pure races of cotton. Of such races, in the earliest stages, only a small amount of seed will be available. This work is, further, centralized; reduction in the number of races has to be effected and such reduction must be accomplished by trial under conditions more nearly approaching those of the cultivators' fields. In particular, these trials must be carried out with a view to testing the relative suitability to the different environmental conditions found in the cotton growing tracts: in other words, trial requires to be made with a view to bringing into prominence any particular adaptability of the race to the type tracts to which reference has been made. Such work must, from its very nature, be decentralized.

As the result of such comparative trials under different environmental conditions the number of races which survive elimination will be comparatively small. For these, further trials on a field scale and an organization for multiplying up a seed supply under conditions which will ensure purity are required. The degree of supervision here required is such that direct and complete control by the Ministry is essential.

From the seed supply so produced distribution will be made to extra-Ministerial agencies and here, for the first time, direct contact with the public will be reached. As I have stated above, the amount of seed that can be procured under such rigid control will be, under any organization practicable, but an iota of that required to sow even one type tract. Control, and the organization which accompanies it, cannot, therefore, cease here. That seed must be issued to a circle of selected and more reliable cultivators with whom arrangements for the repurchase of the crop for the purpose of increasing the seed supply are possible. These cultivators will, in the following year, be supplied with a fresh stock from the directly controlled Government stock, while the seed recovered from them is issued to a further set of cultivators.

I may set out the above scheme in tabular form:—

- (1) Research—the isolation of races in a condition of purity.
- (2) Experimental trial—small cultures grown comparatively under differing environmental conditions.
- (3) Field trials—in those tracts only which the trials under (2) have proved suitable.
- (4) Seed production—the bulk development of a pure seed supply.
- (5) Seed distribution—the organization of a seed supply sufficient to meet the full needs of the tract.

We are now in a position to consider the equipment that will be needed to allow the successful development of this scheme for passing from the experimental to the practical issue. At the foundation of the scheme is the Botanical Section which will require a *Research Farm*. On this farm will be conducted, by the botanical staff, all that work which aims ultimately at the production of pure races. With a three-year rotation and an area of 25 to 30 acres under cotton at one time, some 70–90 acres will be needed for this farm.

For the experimental trial of such races as result from the botanical research farm small experimental plots, totalling two to three acres, will be required and these must be repeated in each

recognized type tract. The number of races sufficiently promising to be subjected to such tests will be relatively small for any one season. Repetition is, however, an essence of the trial in order to reduce, as far as possible, the probable error, and the area here given will allow for the necessary repetitions to be made at each centre of trial. These areas are too small to form a unit in themselves and they may conveniently form part of an *Experimental Farm*.

An experimental farm will be required for each definite tract and will form the site on which will be conducted all the purely agricultural experiments including, in addition to the experimental trials just alluded to, the field trials forming the third stage of development. For each of these an area of some 150 acres will be required.

Seed multiplication demands a distinct area, or *Seed Farm*, with a minimum of 150 acres giving 50 acres of cotton. Specialization is here required to ensure purity. Again, one such farm is required for each type tract as defined above.

The seed derived from the seed farms is available for distribution and for this, as follows from what I have already said, no equipment in the form of land is needed.

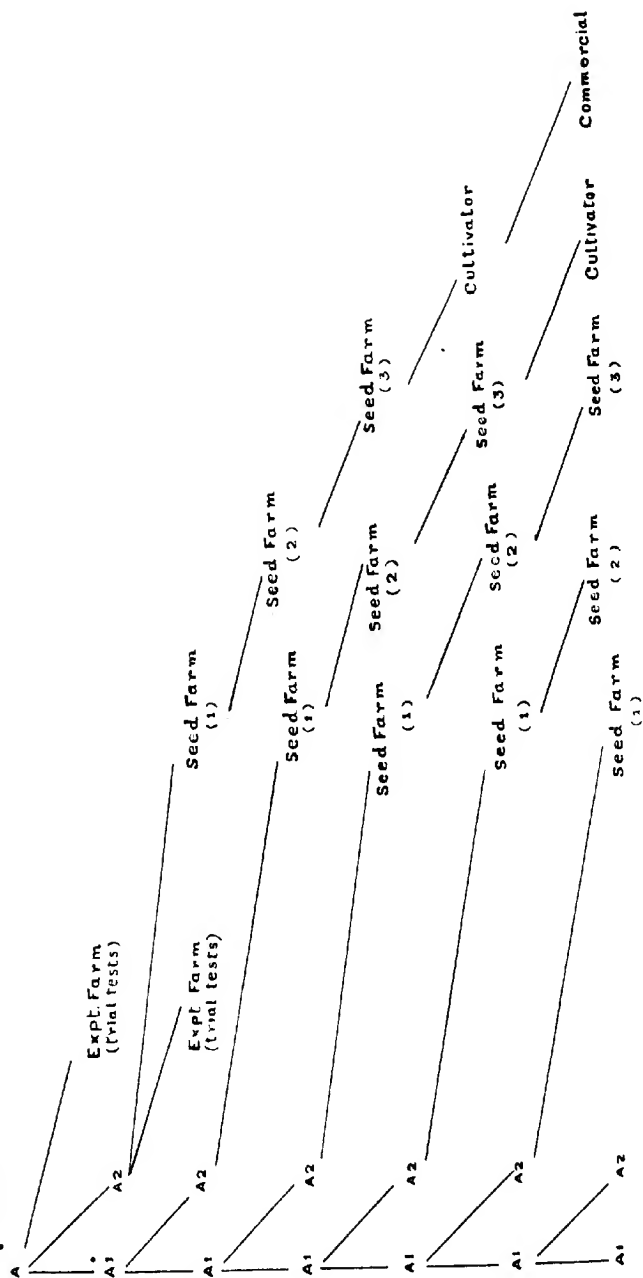
We may now turn to the question of organization which will realize most completely the opportunities offered by the institution of such farms throughout the country.

As before, I may commence with the Botanical Section with its staff engaged in detailed investigation leading up to the establishment of pure races which, in the first instance, will amount to cultures each totalling in the neighbourhood of some 200 plants. From such cultures sufficient seed will be available to provide a supply for the experimental trials and also to multiply up, on the research farm, a seed supply of sufficient magnitude to sow 1-2 acres. Of those races which satisfy the preliminary experimental tests there will thus be sufficient seed to carry on to the seed farm which will be fully stocked in the third year.

The Agricultural Section with its staff controls the experimental farms and, by conducting the experimental trials, will have early opportunity to become familiar with the results of the work

The diagram illustrates the flow of seed from a pure race to commercial cultivation through various stages of experimentation and seed farming. The flow is as follows:

- PURE RACE** (represented by a triangle with vertices A, A1, and A2) is the starting point.
- From the pure race, seed is sent to **Expt. Farm (trial tests)** (represented by a triangle with vertices A1 and A2).
- From the experimental farm, seed is sent to **Seed Farm (1)** (represented by a triangle with vertices A1 and A2).
- From the seed farm (1), seed is sent to **Seed Farm (2)** (represented by a triangle with vertices A1 and A2).
- From the seed farm (2), seed is sent to **Seed Farm (3)** (represented by a triangle with vertices A1 and A2).
- From the seed farm (3), seed is sent to **Cultivator** (represented by a triangle with vertices A1 and A2).
- From the cultivator, seed is sent to **Commercial** (represented by a triangle with vertices A1 and A2).



of the Botanical Section. It will also have the opportunity of forming an independent opinion of the value of the various races submitted for trial. Such check is valuable, affording, as it does, criticism from a different angle. The ultimate selection as to which races are to be continued and which discarded will rest jointly with the botanical and agricultural officers.

The seed farms are not so readily allocated. Their primary function is to work up a stock of pure seed and for this purpose botanical control and botanical examination are desirable. At the same time their location makes centralized control difficult while, for the same reason, they fall naturally into a district organization. We have here to strike the balance between the different disabilities, and I am inclined to think that the deciding factor should be one of individuality. It might be found advisable to adopt a middle course in this matter, placing the seed farm nearest to headquarters under the Botanical Section and the remainder under the respective district agricultural officers.

From the seed farm seed is issued to the cultivators, using that word in its widest sense. The selection of these is a matter for the district officer whose knowledge of his district should be such as to enable him to select the more reliable cultivators for the purpose. These may be actual cultivators or landholders who take a personal interest in the management of their estates. No doubt, too, valuable assistance could be rendered by the State Domains in this direction.

Before proceeding to the discussion of the wider distribution of seed with the precautions necessary to maintain purity I may summarize the scheme here outlined by a diagrammatic representation of the stages in the development of a pure race.

The diagram opposite indicates the method by which purity is maintained up to the commercial stage with which we have now to deal. It may be described as a series of waves originating with the research farm and passing from thence outwards. There is no backward flow of seed and the effect of any accidental cause leading to impurity is, thus, eliminated automatically.

The agricultural organization conceived in this scheme is one of a series of circles (to use an Indian term) based as far possible on type tracts and, therefore, since these are determined by environmental conditions, on climate. Each circle will be in charge of a circle officer whose work is dual. On the one hand, he will have control of an experimental farm and, on the other, he must develop an intimate knowledge of his circle and be in a position to select reliable men to whom he can entrust the cultivation of the seed issued from the seed farms. The former, to be properly developed, will require a great deal of personal work involving residence at the local headquarters at the busiest season, the latter frequent touring. The two functions are incompatible and if one or other line of work is not to be neglected, it seems essential that two officers should normally be allowed on the strength of each circle, an arrangement which has certain administrative advantages.

V.

With such an organization the maintenance of purity in the seed supply up to the stage when issue is first made to the public should not offer any great difficulty. We have now to consider the organization required for the further multiplication of that seed. It is here that the work of the Commercial Section will commence. Such a section is already in existence, but its activities have been confined to the supply of seed to the smaller cultivator and in 1919 approximately 30 per cent. of the cotton area was sown to seed so issued. Effective though that organization appears to be, it does not strike at the root of the problem. The seed is sown under no control and is of little or no value in increasing the supply of purer seed. Many of the larger cultivators too appear to be as careless as the smaller in this matter. It is immaterial whether the cause is ignorance or economic pressure, the effect is the same. Some more general control of the seed supply is needed, and such control must avoid the assumption by Government, as represented by the Ministry, of the function of a general dealer in seed. It would appear possible, by working along the lines indicated below, which are the outcome of conversations held by me in Alexandria, to

evolve a workable scheme which will ensure a certain standard of seed and, at the same time, provide the means of working up as far as may be necessary, while maintaining purity, the seed of the races which find their origin in the work of the Botanical Section.

The agricultural organization, as we have traced it, gives a seed supply sufficient to sow 500 acres. Allowing a margin for cases in which doubt attaches, the circle officer should be able to recover seed sufficient to sow 4,000 acres in the succeeding year. He will be able to locate the fields planted to that seed, but it will be beyond his means to recover the seed. Were he now to notify the ginneries of the names of these growers with the area grown by each, it should be possible to intercept a fair proportion of the crop so grown as it comes into the ginneries and, by arrangement with the ginner, this could be ginned and the seed kept separate. Such seed will now receive a Government mark indicating that it is passed as taqawi (cotton seed used for sowing). I am here making various assumptions; I assume an intimate local knowledge on the part of the circle officer which will enable him to select reliable men; I assume the form that reliability takes will include a willingness to deal with the ginner selected, and I assume the existence of ginneries who appreciate the importance of a guarded seed supply sufficiently to take the necessary trouble. From what I have been able to gather on these matters I am inclined to think that all these assumptions are well founded.

The ginner will now dispose of this taqawi seed in the normal course of his business but will keep a record for the information of the circle officer of the purchasers. The latter will thus be able, by a system of inspections during the succeeding year, to draw up a list of cultivators whose crop is sufficiently pure to serve as a source of taqawi. His selection will continue until he can find no more fields sufficiently pure to serve as a basis for seed supply—a condition which will occur during the early years of introduction—or until he has arranged for a sufficient supply, allowing for wastage, to meet the needs of the tract it is desired to plant to that kind.

I have described the organization with especial reference to the introduction of new races but, as I conceive it, that will not be the

main function of the scheme. I conceive the scheme, as described, merely as the preliminary stage in the evolution of a more complete one aimed at licensing the ginneries for taqawi.

The licensee will keep a record—

- (1) of the cultivators whose crops have gone to the production of taqawi, including a statement of the kind and the amount;
- (2) of the persons to whom he has disposed of that seed, again including a statement of the kind and amount in each transaction.

In the selection of the seed cotton he will be guided by information supplied him by the circle officer aided by his own judgment. Where the source has not previously been inspected the seed cotton will be passed by the circle officer before it is ginned. All such taqawi seed will receive an official seal. The disposal of this seed will be subject to no further control than is indicated in (2).

These two lists, I suggest, should go to the Commercial Section of the Ministry, which will, thus, be in a position to collate the information with regard to seed supply by circles and to furnish the circle officers with such collated lists. The Commercial Section will also be responsible for extending the present distribution of seed to small holders,* for which it will obtain its supply from the sealed stock in the hands of the ginneries, but the supply to the larger holders will remain uncontrolled.

Under this scheme, when fully developed, the circle officer will be in possession, through the Commercial Section, of information as to the source of the seed from which a large proportion of the cotton in his circle is grown. He will thus be in a position to check to some extent the efficacy of the system of licensing. By using his local knowledge and concentrating on the larger holders he will be in a position to exercise control over the bulk of the cotton crop of his circle with the minimum of effort.

* The maximum amount issued in one lot is 10 ardebs (1 ardeb=5.44 bushels), or sufficient for 25 feddans (1 feddan=1.04 acres), representing a holding of between 50 and 75 feddans.

I am not here concerned so much with the development of a scheme practical in all its details—for such, practical experience and a local knowledge I do not possess is essential—as with outlining the main features any scheme, to be effective, must possess. Among such features I place the absence of penalty against the licensee. Success or failure will depend very largely on the goodwill of these.

In the "Agricultural Journal of Egypt," Vol. VIII, p. 69, an account is given of the system of control of taqawi instituted in connection with the control of cotton seed organized in 1917. The problem was then approached from a different standpoint and the control is, therefore, of a somewhat different nature to that which I have just suggested. It introduces control at a stage when that control is difficult of application and of a nature which, at first sight, appears to be restrictive. It is, for that reason, that I hesitated to suggest any control at this stage. The fact that the scheme has been developed without serious criticism from the financial interests affected makes it worth considering whether its institution on a permanent basis is not desirable. It is truly complementary to the scheme I have here proposed; there is no fundamental incompatibility between them, since they do not cover the same ground, and there should be no great difficulty in making the two dovetail into each other.

There appear to be a body of responsible ginnerers who fully recognize the importance of seed control and who would willingly undertake to make such returns. The position is more nearly that of a co-partnership for mutual benefit than one of enforcement of a restrictive order. For the services provided, Government guarantees a partial monopoly. In such a system any penalty beyond the removal of the license is inadmissible, and penalty, if any be required, will be imposed on the purchaser of non-guaranteed seed. The use to which the returns are put will end normally with the check which they will enable the district officer to make. Of one fact I am thoroughly convinced, if a scheme based on the goodwill and co-operation of the ginner be wanting in success, no scheme, based on compulsion and the enforcement of penalties will lead to any better result.

It is recognized that any scheme such as I have outlined will throw a considerable amount of work on the circle officers to accomplish which a large portion of their time will be spent in touring. It is very largely recognition of this fact which is responsible for the suggestion that the normal senior staff of the circle shall be two; the senior engaged mainly in touring and the district work and the junior on experimental work.

I have left reference to the economic aspect till the last because the discussion of the system outlined for the introduction of new, and the maintenance of purity in old, races throws a certain light on this. Statistical information is required both of the relative quantities of the different classes grown, of the value realized for these, and of the development of cottons capable of replacing these but grown in other countries. The system I have outlined for licensing ginneries and the information contained in the lists proposed in connection with that system should provide the materials for a very accurate estimate of the relative areas sown to the various races, and it is partly on this account that I have suggested the centralization of the work of abstracting these in the Commercial Section. Information with regard to prices and to the cottons produced in countries other than Egypt must be derived from external sources. With a definite idea of what information is required, it should not be difficult, by enlisting the services of the Empire Cotton Growing Committee, of the Fine Spinners Association, or of the International Federation, to arrange for statistics to be prepared in suitable form. The work of collating and recording this information requires no separate section and might conveniently be entrusted to the Commercial Section.

VI.

It will, perhaps, render these proposals clear if I refer to a few practical problems of the present day and show in what manner the scheme outlined will affect their development.

Mr. Bolland, some years ago, commenced a series of selections of the standard Egyptian cottons with a view to developing cultures of these which would give a more uniform product than is now

commonly attained. Of these, we may consider the Ashmouni culture. His method is, to describe it briefly, based on single plant selection of typical plants. The offspring of these single plants are grown separately, are examined in detail, and the seed of those plants which conform most nearly to the ideal of the Ashmouni type is harvested again separately, and sown the following year, as single plant cultures to form his Grade I crop. The seed of the remaining plants is harvested and bulked together to form his Grade II crop. In the following year the single plant Grade I cultures are again examined and from them single plants are selected. The remaining Grade I plants provide the next year's Grade II crop while the Grade II crop is sown as Grade III crop.

This process is repeated annually, the seed from the Grade III crop being issued to cultivators who grow it as Grade IV crop. Certain of these cultivators sow it under Ministerial supervision and the Ministry retains the right of purchase of the produce from this in the remainder of the Grade IV crop and, subsequently, control ceases and the amount of controlled seed at the disposal of the Ministry is, thus, limited to that from the controlled portion of the Grade IV crop, or enough to sow some 500—600 feddans.

This area is a mere fraction even of that which is sown to the Ashmouni seed distributed by the Commercial Section of the Ministry—over 100,000 feddans in 1919—and the Ministry is compelled, therefore, to seek its supply from ginneries. Now if this seed, selected on Mr. Bolland's scheme, is materially to affect the Ashmouni crop, and that presumably is the only justification for the labour incurred in that selection, the Ministry must check the sowings and trace the produce of those crops which it finds to be sufficiently pure to the ginneries and must purchase the seed obtained from it to form what we may term a Grade V crop. Let us examine the practical aspect of this more closely.

In a letter recently received by the Ministry, I find the following remarks; they refer to produce from the uncontrolled section of the Grade IV crop:—

"The cotton was grown in two villages; the sample from the former shows a good coloured brown Ashmouni with as good staple

as we have seen this season; there are, however, streaks of lighter coloured cotton which is curious, seeing that the seed is pure....." The latter "is however entirely different to the first lot; it contains a short wasty cotton and the class is barely F. G. F. It is surprising that it is supposed to be the same seed and perhaps you may be able to indicate the cause of deterioration."

Again I have examined some samples of the seed cotton of this same Grade IV crop and have found it more mixed than the majority of commercial samples of Ashmouni that I have seen. In the former case, there is a distinct and large divergence between the produce raised from two identical lots of seed; in the latter, admixture sufficient to render the produce less uniform than most of the uncontrolled Ashmouni crop.

The explanation cannot be given with certainty since there have been no independent observations of the various crops concerned, but it is probably this. In the first case both crops are sown with the controlled seed and in one instance germinations were successful and resowing unnecessary; in the second instance, a large proportion of the crop consisted of second sowings and these were made with seed of different origin. The second case forms a parallel to the second instance of the first case and second sowings with seed of different origin was largely resorted to. In the first of these three instances only can the crop be truly considered to be of Mr. Bolland's Ashmouni, the seed of the remainder is worthless for further distribution. Yet, the name is retained for the produce of all these cultures and the Ministry has no means of judging which are the reliable lots when it comes to purchase from the gins. The cessation of control after the Grade IV crop, therefore, renders it impossible to assure a supply of reliable seed for more than 500—600 feddans.

Were, now, an organization, such as I have outlined, to be in operation, the district officer would be in a position to see that these 500—600 feddans belonged to responsible persons who could be relied on to carry out any resowing with the same seed as that supplied. His local knowledge would, moreover, enable him to place the entire Grade IV crop in the hands of reliable persons. Even

supposing he fails to exercise any supervision over the distribution of the seed and the sowings, he would know where it was growing, could inspect the crops, see which of these maintained their purity, trace these to the ginneries, and so place at the disposal of the Ministry a yearly increasing supply of seed of known quality.

As a second instance, I may take the case of the Domains. Here Mr. Jeffreys has, for a number of years, devoted much labour to purifying the field crops of some of the more important varieties of Lower Egypt, notably Sakel and Assili. His method differs from the above and may be termed bulk selection. From the field crop, before general picking commences, he collected a bulk of seed taken only from those plants which correspond to the ideal of the type in question. The seed from the produce so collected is sown separately, rogued during the course of its growth and again gone through before harvest, and a similar amount of seed cotton of the most typical plants taken. The remaining seed is used to extend the area under the selected crop. In this way he has worked up an area of 10,000 feddans in which the crop is manifestly purer than any I have seen elsewhere, and it forms a distinct advance in uniformity on any of the crops commonly grown. He has also maintained on a fair scale in a state of considerable purity many other types, notably those evolved by Dr. Balls. We are here, however, only concerned with the two varieties, Sakel and Assili—of which a commercial seed supply is raised. Under present circumstances that seed, totalling 13,000–15,000 ardebs, is used partly by the Domains for sowing the area under their direct cultivation, using some 3,000 to 3,500 ardebs: partly for sowing a large area of leased lands, absorbing some 5,000 to 6,000 ardebs. The remaining seed is placed at the disposal of the Ministry which distributes it through the Commercial Section to cultivators in small lots. In all except the first case, and the extent of that is only sufficient to produce the same volume of seed yearly, control ceases. The subsequent cultivator is usually a small man who may, or may not, resow with seed of unknown origin.

Apart from the difficulty of re-collecting from a large number of small holders, the value of such seed for taqawi is very

questionable. Practically, therefore, the efforts made on the Domains merely result in the maintenance of a certain fairly constant volume of seed and there is no cumulative effect leading to increase.

Here, again, were there an organization such as I have outlined, the Domains seed would pass to the larger private estates, the district officer would be supplied with particulars of these, would inspect the crops, note which are the purest of these, trace them to the ginneries, and place at the disposal of the Ministry for distribution to the smaller cultivators an ever increasing source of supply of reliable seed.

VII.

I have indicated the essential points of an organization for the development of improved cottons and for the introduction of these on a commercial scale under conditions which will maintain a sufficient degree of purity. As described, the outstanding feature of that organization is continuity. But while continuity is essential to the successive stages of that development, such continuity is not possible in the organization. At least three sections of the Ministry, the Botanical, the Agricultural and the Commercial, are concerned. Success will depend on the maintenance of that continuity of work in spite of the discontinuity of agents, and the danger to the scheme lies at those points where the activities of two agencies meet. The function of organization should be the prevention of any hiatus occurring at these points and it should leave the maximum of freedom within the sections themselves.

This necessity for continuity requires to be emphasized. Recently a Cotton Research Board has been instituted with the underlying idea that the control of cotton research shall be undertaken by it, leaving the practical aspects of the problem to the Ministry. Such a division of functions, I think, is hardly consistent with the development of the continuity I hold to be essential for the successful development of the scheme. It institutes a duality of control which is almost certain to lead to a break in continuity, and to the establishment of the hiatus it is most desirable to avoid.

The idea underlying the separation of research from practice appears to be based on analogy with English conditions. Here the tendency is in the direction of such separation. I am inclined to think that this analogy is not a true one, especially in matters like agriculture. In England the farmer is educated and he appreciates the value of improved seed in crop production. He himself carries out the later stages of seed production inasmuch as he purchases a limited amount of pedigree seed and, from the crop produced from this, sows his entire area if the trial proves the superiority of the race under the local conditions. He is, thus, able and willing to pay a high price for pedigree seed, for the amount he has actually to purchase is small. It is that ability and willingness which makes the production of pedigree stock a financial proposition for the seedsman. In Egypt the conditions are far different. The cultivator is uneducated and even illiterate. There is no general recognition of the value of pedigree stock, no willingness to pay a high price for such, and, consequently, no encouragement for the seedsman and plant-breeder on a financial basis. Government must control the seed supply not only during the early stages but throughout. Not only, therefore, is continuity essential in the Research Section pure and simple, but that continuity must extend to the Commercial Section as well—a continuity which is not likely to be fostered by widening the breach between research and practice. Such continuity will, in my opinion, be best maintained by the institution of a Cotton Committee within the Ministry itself. This committee will be composed of the heads of the various sections concerned with the development of cotton and will sit under the presidency of the Under Secretary of State for Agriculture. It will deal with all matters of a general nature affecting more than one section and decide all questions of principle. It must, however, avoid any interference with the actual work of the individual sections once the general lines of policy have been decided. The decision as to what shall, or shall not, come before the committee must rest with the Under Secretary of State. Further, the committee will form a convenient body to deal with any matters of general principle now referred to the Under Secretary of State by Government. The committee should be flexible, and that

flexibility may be given to it by a power to co-opt members for particular purposes.

It, perhaps, carries me too far beyond the range of my terms of reference, but it may help to render my conception of the working of this Ministerial committee more clear, if I say that I look upon this committee merely as one of a number of such committees. It is, in my opinion, the most satisfactory means of dealing with all technical subjects which concern more than one section of the Ministry. On the one hand, they form a most convenient means for deciding, by mutual discussion, the lines of work of the different sections, so that these may dovetail into each other while, at the same time, automatically placing on record a Ministerial policy; on the other, they form a definite body to which the Under Secretary of State can refer such references on technical matters as are received from Government and from which he can obtain an authoritative technical opinion.

The field presented by the cotton problem, however, in its entirety, extends beyond the scope of the Ministry of Agriculture. On the one side, there are the Domains. These form an enormous potential asset for the development of a controlled seed supply. I have already shown how it is that the Domains have failed to pass from a potential, to a practical, asset in this respect, and how it is that the very successful efforts are largely dissipated. A liaison requires to be effected between the Domains and the Ministry by which such questions as the varieties it is desirable that the Domains should grow, and the distribution of the seed raised on the Domains' land, can be settled. On the other side is the physical investigation for the conduct of which the Physical Service is relied on. It may also be remarked that the development of that work may raise important questions of water-supply which will involve the Irrigation Department. At least three extra-Ministerial bodies are, thus, concerned and between them some liaison is desirable.

I am aware that my proposal for the establishment of a committee within the Ministry will appear to undermine the position of the Cotton Research Board as at present instituted. This it undoubtedly does, but it indicates the desirability of a Board

occupying the same position with respect to the Ministry as the existing Board but with somewhat different functions. By the decree instituting that Board its function is defined as 'to combine, co-ordinate and extend the quality and yield of cotton grown in Egypt.' From the general aspect I have already indicated the undesirability of separating research from practice in the economic conditions prevalent in Egypt and, from the particular aspect, there appears to me the danger of a most undesirable duality of control. As I conceive it, the Board should serve the function of liaison agent between the Ministry of Agriculture and such extra-Ministerial bodies as are concerned with the cotton problem. The Ministerial note explaining the decree says 'the Board will maintain' close touch with cotton grower, ginner and spinner so as to know their 'needs.' I have dealt with this aspect elsewhere. It is the work enumerated by me as economic. I have suggested that this be performed by the Commercial Section and provision has already been made for it in the proposals I have already made.

(To be continued.)

FLAX IN THE UNITED PROVINCES.

BY

B. C. BURT, B.Sc., M.B.E.,

Deputy Director of Agriculture, Central Circle, U. P.

IN a recent number of "Capital" an extract was published from a note on the prospects of flax cultivation in the United Provinces, originally published at the request of the United Provinces Department of Industries in 1915, and which was reproduced at the time in the "Indian Trade Journal" and in several periodicals. When that note was written the price of agricultural produce had not been materially affected by the war, and although flax had risen substantially in price it had not reached anything like its present high level. Nor was there any indication of an acute world shortage of flax such as is now apparent.

In the note referred to it was shown that several years' experiments at the Cawnpore Experimental Farm had proved that flax could be successfully grown in the canal-irrigated tracts of the U. P. On the basis of the Dooriah factory¹ experiments, with flax at about £60 per ton and with a fibre percentage of 8 per cent., Mr. Vandekerkhove estimated that a central factory could afford to pay R. 1 per maund (82·3 lb.) of rippled straw to growers. At Cawnpore the percentage of good fibre to straw was 10 to 12, and on this basis, prior to the war, U. P. flax was worth at least R. 1·4 per maund.

It was shown that yields of 40 maunds per acre of rippled straw could be obtained without difficulty, given irrigation, and that in a favourable year 60 maunds might be expected. On this basis and assuming pre-war prices for wheat and similar crops, flax,

¹ *Pusa Bulletin* No. 30.

when due allowance was made for the value of the seed, was worth as much as an average crop of wheat at even R. 1 per maund for straw.

Conditions have now materially altered; the prices of wheat and other food grains have advanced materially and, although there was a temporary fall at the last harvest, it seems not unlikely that future calculations must be based on five rupees per maund for wheat and at least eight annas per maund for straw (*blusa*) except in villages remote from the larger markets. With the higher yielding Pusa wheats, now established over very considerable areas in the neighbourhood of Cawnpore, yields of 20 maunds per acre of grain and approximately 40 maunds of straw are being regularly obtained by a large number of wheat-growers, and with good cultivation substantially higher yields are not uncommon. Flax as a canal-irrigated crop would come into direct competition with wheat from the grower's point of view, and an acre of flax would therefore need to yield at least Rs. 140 to equal wheat. Allowing for the somewhat increased labour required for pulling and handling, and for the fact that no grower would abandon a food crop for a purely commercial crop unless he saw considerable profit in doing so, it is clear that flax would no longer be a profitable crop at R. 1 per maund of straw.

On the other hand, the present price of even medium quality flax is in the neighbourhood of £300 per ton, and it seems unlikely that within the next few years it will be less than £150 per ton. A central factory could, therefore, afford to pay some Rs. 5 to Rs. 6 per maund for rippled straw for a number of years. This would give the grower some Rs. 200 to Rs. 240 per acre for his straw in an average year.

The value of a flax crop at the present time is materially enhanced by the price of the seed, since seed imported from England costs at least Rs. 40 per maund. On the other hand, if the seed is not so handled as to be fit for sale for fibre growing its value will be slightly less than that of ordinary linseed, say, Rs. 8 per maund. •

Although flax can be successfully grown in the U. P. it cannot be too clearly stated that there is not the slightest chance of

flax-growing developing as a purely village industry. The retting and scutching of flax require an amount of care and attention impossible in the average village. Nor is the average cultivator in a position to finance a crop of this kind, the seed for which would cost some Rs. 60 per acre, unless he has a definite guarantee of a purchaser for his straw. Given a central factory for retting and scutching, there would be little difficulty in persuading cultivators to grow flax. Without a central factory no progress is possible.

In addition to purchasing straw for cash it would also probably be necessary for the central factory to finance growers to a certain extent, particularly by supplying seed on credit. In view of the present marked discrepancy between the price of flax seed and ordinary linseed it would be desirable for the central factory to make its own arrangements for rippling and to purchase the seed on the straw. Working on these lines advances in kind could be safely made and the central factory would automatically obtain a supply of seed for the extension of its operations since the surplus seed could be purchased from the cultivator at a reasonable price.

Flax when grown at Cawnpore appears to degenerate gradually if constantly grown from local seed. This was very clearly shown by experience at Cawnpore with flax obtained originally from Holland, which had been acclimatized in Bihar for one year. For about three years flax of good quality was obtained, after that degeneration was fairly rapid and the fibre obtained was too short for anything but the coarsest spinning. Hence any business concern taking up flax would have to face the necessity of importing a certain proportion of its seed annually.

RECENT EXPERIMENTS.

In October 1919 English flax seed (Dutch Child) was obtained from the Ministry of Agriculture (Flax Production Branch) and also a small supply of Japanese seed from the Flax Control Board. The latter was believed to be of Dutch origin but its parentage is not known. Both these varieties grew well at Cawnpore. Full figures are not yet available as the bulk of the crop has been retained for retting and scutching during the coming cold weather in accordance

with previous practice. The yield of straw per acre was lower than usual—Japanese flax 42 maunds per acre, English flax (Dutch child) 35 maunds per acre—on account of an unusual shortage of canal water (such as has not been recorded at Cawnpore for some 8 years) which prevented adequate irrigation being given. The seed yields were $5\frac{1}{2}$ maunds per acre for English flax and 7 maunds per acre for Japanese flax. On a preliminary trial the fibre percentage was 17, which is unusually high, but this figure requires confirmation under normal conditions. The crop grew well and the length of the fibre was satisfactory.

Throughout the Dooriah flax experiments retting and scutching was postponed until the beginning of the cold weather following the harvesting of the straw. This involves the locking up of capital for a period of six months and, under present market conditions, the central factory would also have to take the risk of very considerable market fluctuations. Though possibly not a disadvantage at present this might be sufficient to cause material loss when flax production in other countries recovers. Experiments were, therefore, carried out to see whether retting and scutching could be performed in April immediately after the flax harvest. The high temperatures caused less difficulty than was expected in retting. Scutching was difficult on account of the intense dryness of the air and could only be carried on in a closed room artificially kept damp. During the monsoon retting would be impracticable, but scutching appears to present no particular difficulty. Until valuations are received of flax retted and scutched in April and flax from the same crop retted and scutched in October-November it is not possible to say how far hot weather retting is feasible, but the point is obviously of considerable importance.

SOME OBSERVATIONS ON THE ROOTS OF FRUIT TREES

BY

W. BURNS, D. Sc.,

Economic Botanist, Bombay ;

AND

L. B. KULKARNI, L. Ag.,

Of the Bombay Agricultural Department.

THE following observations were made on the roots of *Citrus* trees in two places, and on the roots of guava trees in one place.

CITRUS.

The Vernacular Agricultural School at Loni, near Poona, had a fruit plot which was not entirely satisfactory, being planted to a number of varieties of fruit trees some of which grew indifferently. It was decided to take out all these trees and replant with one variety. Opportunity was taken to expose fully the root system of a typical orange tree of the loose skinned type (*Santra*) and also the root system of a typical orange tree of the tight skinned type (*Mosambi* or sweet lime). The following history of the plants is of interest. There was one line of each. Both were budded on the *Jamburi* stock, a variety of *Citrus medica*. The soil was alluvial loam, varying in depth from 1 to 2½ feet, with hard trap just underneath. The surface slope was about 5 degrees (estimated) running down to a *nulla*. The trees were planted in November 1914, and so were nearly five years old when the roots were exposed in October 1919.



Fig. 1. *Santra* tree at Loni, showing spread of lateral roots.

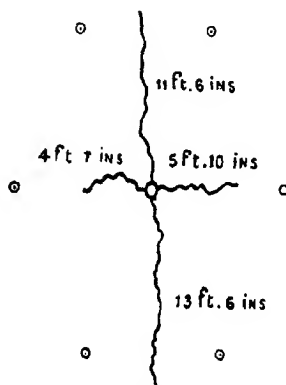


Fig. 2. *Mosambi* tree at Loni, showing spread of lateral roots.

For two years after planting the plants were irrigated in basins up to the stem. These basins were of a radius of 3 feet. Thereafter ring irrigation was practised, the ring being widened yearly. The rings were cultivated by hand after each irrigation. General cultivation with a disc harrow was given once a month, and the soil was ploughed thrice a year to 5 inches deep.

Water was given not at fixed intervals, but when the trees showed signs of needing it. The minimum interval was 10 days, the maximum 20, and the average 15 days. No root exposure was practised, and the trees flowered without any forcing. All did not flower at the same time, but the majority flowered in June. No inter-crop was taken after May 1917. The inter-crop previous to that date, if any, is unknown.

While exposing the roots, one interesting physiological fact came to light. Exposure of the roots was begun on October 9. On October 11, the horizontal spread of the roots was entirely exposed. The plants remained thus without wilting till October 13, when they were examined. During this period the average day maximum temperature was 93° F. and no water was given. The plants' resistance to drought, with only a few roots left as absorbing organs, is therefore remarkable.



Text-fig. 1

Plate XXXV, fig. 1, represents the *Santra* tree, and Plate XXXV, fig. 2, the *Mosambi* tree.

The following points are noticeable:—

- (1) The relatively great spread of the root system. The height of the *Santra* plant was 10 feet 4 inches from the soil level.

The root lengths laterally varied up to 13 feet 6 inches, with an average of 8 feet. It will be seen from the plan (Text-fig. 1) that the greatest length of roots occurred on the side where, in the quincunx arrangement of the

trees, there was a way for them to get between the trees in the next row.

The *Mosambi* tree had a height of 7 feet 4 inches, and a trunk diameter at soil level of 4 inches, which diminished to $1\frac{1}{2}$ inches at 18 inches below the surface (presumably the tap root). The average radius of the root circle was 6 feet 10 inches.

- (2) The next point of interest and importance is the comparative shallowness of the lateral roots. These, in both cases, started from 6 to 12 inches below the soil level and then spread out, branching and gradually rising in the soil. All these terminated in small richly-branched masses of feeding roots. Besides these lateral roots there were two or three roots of from one to half-an-inch diameter going deeper into the soil and apparently acting as anchoring roots. These, of course, could go no further when they came up against the hard trap underlying the soil.

Plate XXXVI, fig. 1, shows a 14-year old *Santra* plant, also budded on *Jamburi*, growing in deep medium, black soil in the Ganeshkhind Garden, Poona. The root system is here of precisely the same character. There are well developed lateral roots growing in all directions to an average radius of 10 feet, several roots being as far out as 16 feet, the mean point of origin of these laterals being about 9 inches below the soil surface. The anchoring roots were more strong and thick, but not numerous. This plant was suffering badly from die-back and many of the roots showed rotting, apparently unaccompanied by fungus or insect attack. This tree had had its roots exposed yearly to check its growth and the roots near the trunk were all scarred and injured by the implements used, partial healing having taken place. Plate XXXVI, fig. 2, shows another tree in the same line in the last stage of die-back with all roots so rotten that few remained to be photographed. It is exceedingly likely that this was due to the waterlogging of this heavy soil. Balls¹ records something similar for the cotton plant. He states:—

¹ Balls, W. L. "The Cotton Plant in Egypt," 1912, p. 38.

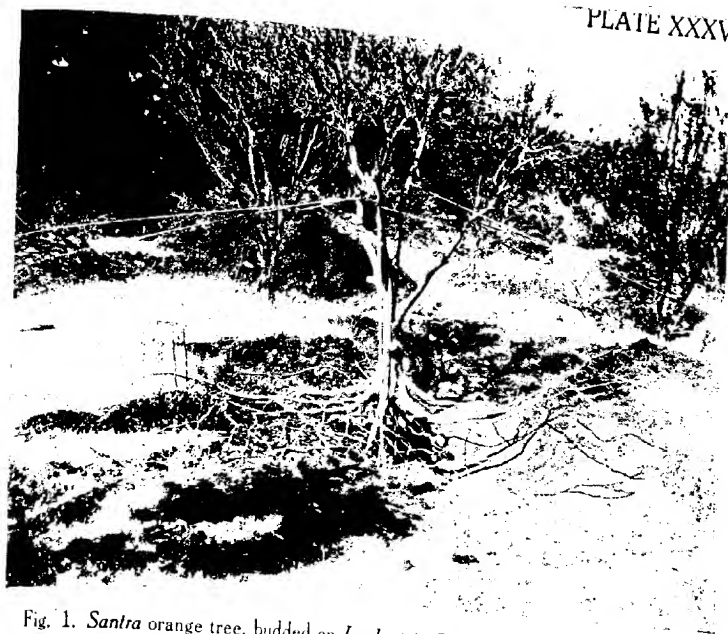


Fig. 1. *Santra* orange tree, budded on *Jamburi*, in Ganeshkhind Garden. Planted in August 1905; photographed on 6th December 1919. Plant suffering from die-back.



Fig. 2. *Santra* orange tree, at Ganeshkhind Garden. Planted in August 1905; photographed on 6th December 1919. Plant dead from die-back.

"Lastly we have to consider an abnormal limiting factor of root growth, namely, deficiency of soil oxygen, usually due to waterlogging of the minute interstices which the soil contains. Owing to the fact that its anatomical structure does not include an elaborate system of intercellular air-spaces, such as aquatic plants possess, the cotton root is locally asphyxiated in waterlogged soil, and in a few weeks even the stout, woody roots are not merely dead but decomposed."

The indigo plant, as we now know, suffers similarly from the destruction of the fine roots in the rains.

The method of irrigation for the past ten years, at least of these trees, had been in basins of 6 feet square. Cultivation had been by hand in the basins and an occasional ploughing and harrowing between the lines. The distance apart of the trees was 16 feet and of the lines was 20 feet.

From the above examples and various other observations we come to the conclusion that the *Jamburi* stock, universally used for oranges in the west of India, is a surface-rooting stock with a fair spread of lateral roots, but few deeply penetrating roots. That the depth of the root system in *Citrus* stocks is largely a specific character independent of the environment has been shown in America. A specially good account of this phenomenon with photographs and drawings is given by J. W. Mills¹ in comparing the root systems of what he calls Sweet-oranges, Pomelo and Florida Sour-orange. It is impossible without herbarium specimens to correlate these with any of our Indian species, but the facts show, for example, that the Sweet-orange is shallow rooting in all conditions. If this be so with our *Jamburi* also, then certain practical points immediately need attention. To begin with, it is obviously quite possible to grow plants on this stock on a soil of only 3 feet deep, if the soil is well drained. Second, cultivation should never be deep once the plants have been established, a maximum of 5 or 6 inches being all that is permissible, and less than that desirable. Third, water should be given all over the plantation after the fifth year, for

¹ Mills, J. W. "Citrus Fruit Culture." 1902, pp. 10-19.

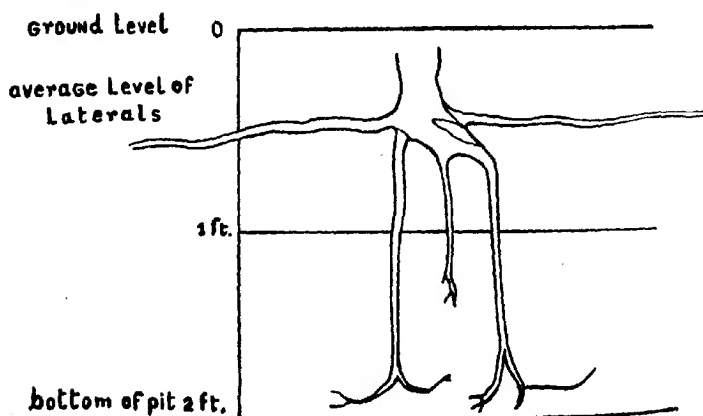
the roots are there. It may be desirable to irrigate different parts of the soil between the trees in successive years to avoid formation of a pan or to arrange for ventilation of the soil, but the water should be distributed all over the ground and not localized. Fourth, manurial experiments conducted with different manures on adjacent lines of trees are worse than useless, as feeding roots from one tree enter the next line and any conclusions drawn will be false.

GUAVAS.

The observations on guava roots are of a somewhat different character. In the year 1915, a piece of very poor ground, having from 2 to 20 inches thickness of soil and underlying it a thin layer of *murum* (disintegrated trap), and then very hard trap, was blasted to give pits in which to plant guava trees. It was hoped that the shattering of the rock would allow this plant of well-known hardy character to penetrate the crevices and so grow.

Seedling guava trees were planted in these pits in September 1915.

The roots of three were exposed in the last week of November 1919 to see what growth had been made. Plate XXXVII shows a typical case. This is plant No. 14. Text-fig. 2 is a drawing showing the root of the said plant to its utmost depth.



Text-fig. 2.



Guava planted in blasted pit. Date of blasting, 12th July 1915. Date of planting, September 1915.
Plant No. 14, variety Allahabad. Date of photo December 1915.

The points of importance are: the plants flourished, grew and developed normally. They seemed to suffer a little in the hot weather but soon picked up in the rains. As an example of their hardihood, we may take their behaviour when their roots were completely exposed for the purpose of the present investigation. The roots were open for 10 days. The plants completely dropped their leaves and appeared to be dead. After 8 days, however, the plants put forth new buds and are now (February 1920) in full leaf again. The root exposure was in the last week of November 1919.

Second, careful study of the roots showed that the roots had actually penetrated the rock crevices between the shattered slabs as we had hoped, and had even made distinct indentations on the softer rock. The shattered rock was gradually disintegrating under the influence of soil, water, and roots.

The average lateral spread of the roots was 7 feet 2 inches and these laterals came off about 7 inches below the surface of the soil. When the vertically descending roots met the underlying rock, or when laterally growing roots met the impenetrable, undisintegrated, unshattered trap, they bent back and went on growing till again held up, much like a root in a pot. In the surface soil, however, there was free scope for root growth.

We may, therefore, generalise and say that in soil of 1 foot deep guavas may be successfully cultivated if the pits are very thoroughly blasted to a depth of 3 feet. The blasting material used was gelignite, in varying amounts, with a primer of dynamite. The cost was six pies per cubic foot.

For trees planted in such conditions, the following points require attention:—

- (1) Water must necessarily be easily available and watering must be regular and at shorter intervals than to plants in normal soil, especially when the plants are in bearing; otherwise the slightest shortage of water makes flowers and fruits wither. Plantations receiving canal water only are not advised, as the water supply may be irregular.
- (2) Root exposure for the forcing of flowers is unnecessary since the plants are easily dried off.

- (3) Pruning of shoots for fruits is not advisable as shoots are short, and there may occur undue exposure of the inner parts of the tree by pruning.
- (4) Since ripe fruits do not keep long on the trees, there should always be a ready market for these fruits.
- (5) With a good supply of water and manure, it is possible to get two crops a year as the period of bearing is shorter than usual. A plant which has borne flowers in June finishes its harvest in November and again bears in January and the harvest finishes in June.
- (6) The actual number of fruits produced per tree has, however, been unsatisfactory, averaging only 25. It is probable that special manuring will overcome this defect.

"THE AMERICAN BLIGHT" OR "THE WOOLLY
APHIS," *ERIOSOMA (SCHIZONEURA)*
LANIGERA, HAUSMANN.

BY

C. S. MISRA, B.A.,

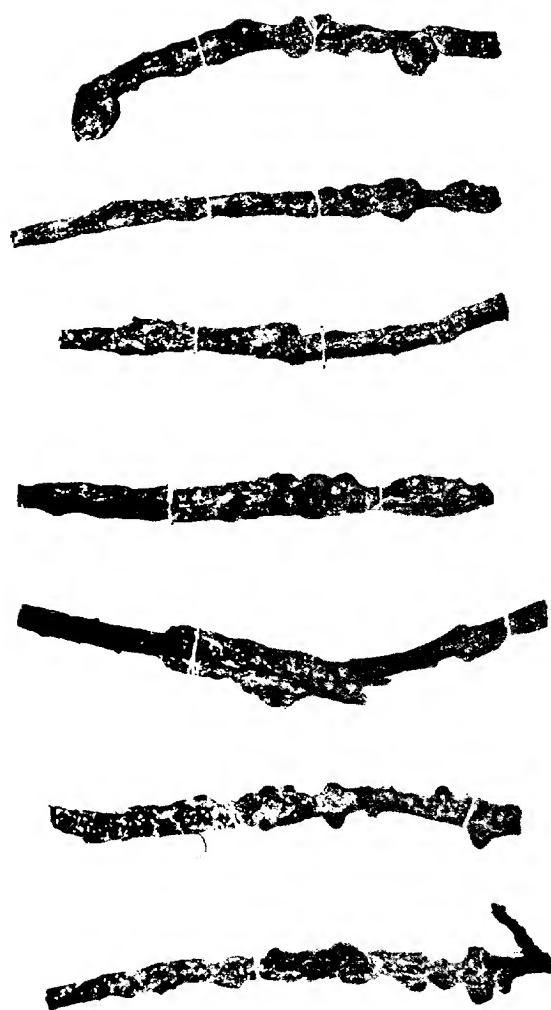
First Assistant to the Imperial Entomologist.

THIS Aphid is known as the "Woolly Aphis" or the "American Blight" and is a very serious pest of the apple. It is known in all the apple-growing tracts of the world and a considerable amount of work has been done on it in England, America, Australia, New Zealand and South Africa. The insect is American in origin and was first introduced into England in 1787 and has ever since been on the increase. It was first noticed in India by the late Mr. Atkinson in 1889 when he wrote that the Woolly Aphis "had destroyed nearly every orchard in Coonoor." Ever since that time fresh localities seem to have become affected and are likely to become so if no precautions are taken now to circumvent the ravages of the worst pest of the apple. It must be borne in mind that if the pest once becomes well established in a locality or localities it is not easy to eradicate it. It has existed to a most alarming extent all through Kumaon, as the following extract from a letter of Lt.-Col. Molesworth, Proprietor of the Bensar Estate, Almora District, April 1910, will show:—". . . There is no doubt that very vigorous measures are necessary or the days of apple culture at least are numbered in this district. At Almora it has existed for many years. The gradual destruction of all fruit trees is very evident. It not only affects the well-grown trees, but is almost invariably found on young saplings and trees before they begin to bear. Hence the trees are diseased from the very beginning, and can never be expected to flourish. It attacks

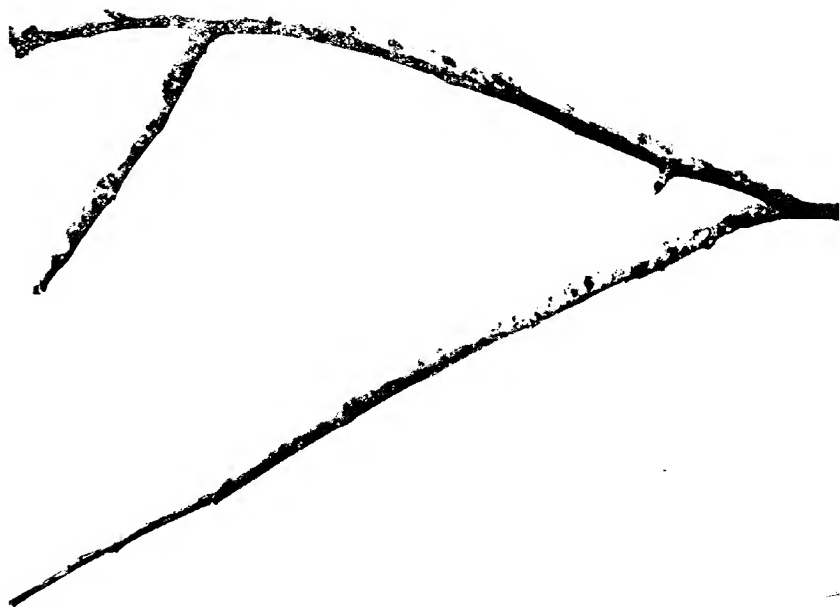
the roots as well as the branches and is the most destructive form of plant disease that can possibly attack trees. Young orchards that may be started in Kumaon cannot possibly flourish until we know how to stamp out the American Blight. It has been stamped out in Italy, and until similar measures are taken here, it is perfectly useless to try and start a fruit industry."

I can personally bear testimony to the above. In 1917, when I was on privilege leave, I had occasions to examine the apple orchards in the Almora District and there it was impossible to find a tree that was free from the pest. The people generally used to bring branches for my examination, but it was useless to suggest remedial measures for a pest that was present underground on the roots of almost all the apple trees in the locality. The people could never be induced to believe that the cause of the death of their apple trees was an insect that was present on the roots of trees underground. That the pest is bad in the vicinity of Simla is evident from an extract of a letter from Lt.-Col. Bernard Scott, dated the 12th October, 1910 :—".....We have here (Kodiali Estate, District Simla) about 1,000 young fruit trees, mostly apples, ranging from 2 to 7 years. Last year some of the apples were attacked by a disease which we take to be Woolly Aphis, introduced we think with a consignment of young trees from England. The varieties of apple we grow are: Devonshire Quarrenden (badly attacked), Worcester Pearmain (badly attacked), King of the Pippins (very slightly attacked), Sturmer Pippin (very slightly attacked), Lady Ludeley, Allan's Everlasting and Cox's Orange Pippin (free). Those trees which are attacked swell at the diseased points into knotty lumps, mostly near the collar, the wounds after healing generally throwing out short aerial roots....."

Last year during October, Major H. R. Wigram, Secretary, Kashmir State Game Preservation Department, wrote :—" I am sending you some apple twigs (Plate XXXVIII) attacked by a white, frothy parasite named by Mon. Pechaad as the 'Woolly Aphis.' It was imported from China some years ago and is now becoming a perfect pest in Kashmir. The only way to save a garden is to cut out and burn every tree that is attacked. This course has been adopted and



AFFECTED APPLE TWIGS FROM KASHMIR (original).



thousands of trees in the garden of the Maharaja, as well as the State gardens, have been destroyed. I cannot believe that there is no cure, and as I am most unwilling to sacrifice valuable trees, I am writing to you for advice. If it means death to the trees, it is, I consider, a very serious matter as the disease may spread throughout India, with disastrous results. It only attacks apple trees as far as we can see, and only some kinds."

A month after, further specimens were received from the Forest Ranger, Sikkim State, Gangtok, from the apple orchard at Lachung (Sikkim). The stems of stocks (Plate XXXIX, fig. 1) as well as the stems of grafted trees were very badly attacked by the Woolly Aphis, and it was doubtful if the trees could survive long the attack of the pest. The roots of trees were malformed into hard convoluted enlargements and could scarcely be expected to perform their normal function. The same was found to be the case with specimens received from Kulu in the Punjab (Plate XXXIX, fig. 2).

The Woolly Aphis is widely distributed, and is present in England, France, Belgium, Germany, Italy, Transcaucasia, the United States of America, Mexico, Chile, Canada, South Africa, the Transvaal, Australia, New Zealand, Tasmania, China, Japan and India. It is known as the "American Blight," the "woolly blight," the "woolly plantlouse," the "woolly apple-louse," the "apple blight," the "woolly louse," the "apple tree root-louse," the "woolly louse of the apple" and the "blood-louse." In France it is generally called "*Puceron lanigère*," and in Germany is known as "*Blutlaus*." In India it is bad in the Himalayas, especially Kumaon and the Nilgiris. It is known to occur at the following places*:

Jalna
Kali
Muktesar
Ranikhet
Chaubattia
Binsar estate

Kumaon, U. P.

* Noted from records available in the Entomological Section, Agricultural Research Institute, Pusa.

Bandrole, Kulu, Punjab.
Kodiali estate, Simla, Punjab.
Bangalore
Coonoor
Ootacamund
Taung-gyi, Southern Shan States, Burma.
Lachung, Gangtok, Sikkim.

} South India.

The Woolly Aphis is not only destructive to young stock, but old trees do not escape from it. The young as well as the adults suck out the sap constantly and thus lessen the vitality of the tree. They puncture the young wood and cause abnormal growths of soft tissues which form rounded swellings which split later on and form rugose deformities so characteristic of the presence of the Woolly Aphis (Plate XLI). Such deformities are sometimes mistaken for the canker. They also damage the roots and form gall-like swellings which do not split. The effect of the presence of the Aphis on the stems as well as the roots is that the plant is unable to withstand the drain and dies prematurely. Those that survive become stunted in growth and produce only scanty and poor quality of fruit. In some places it has been proved that an attack of the Woolly Aphis predisposes the plant to the attacks of the canker.

There are two forms of the Aphid, the one attacking the roots, detected by the knotty appearance of the infested roots (Plate XXXIX, fig. 2), and the other attacking the limbs and the trunk. The aerial form is very prominent and is detected easily by the presence of whitish flocculent patches on the stems (Plate XLI.)

The subterranean form is not so easy to detect unless the roots are opened out and examined. But generally the presence of the aerial form on the branches is an index of the presence of the underground form on the roots of the plant.

The Woolly Aphis was known to attack the apple only, but now it has been proved conclusively in America¹ that the elm is the primary host of the species. If, therefore, there are any elms in the

¹ Baker, A. C. "The Woolly Aphis." *Rept. No. 101, U.S. Dept. of Agri. Bureau of Entomology*, 1915.

PLATE XL.



AFFECTED APPLE BRANCHES FROM LACHUNG , GANGTOK SIKKIM) (original).



WOOLLY APHIS ON BRANCH OF YOUNG APPLE.
(After Washburn.)

immediate neighbourhood of apple orchards, a sharp look-out should be kept, and if any patches of flocculent whitish stuff are found on them, they should be treated promptly and simultaneously with those on the apple. Considerable work has already been done in America and elsewhere and it is presumed that the details of life-history, etc., though they have not been worked out in detail here, will stand good in the case of this country also with certain modifications, though it has been found in France that the Aphid has altered its habits since its importation about 100 years ago.

Those who wish to know the life-history in detail should consult the latest works¹ on the pest, and I think the readers of the Journal will greatly benefit themselves if they were to read what has been effected in Australia and South Africa with the introduction of blight-resistant stocks.

There is no doubt that the pest was introduced into this country on stocks imported from abroad and this points to the danger of importing varieties of fruit trees and flowers without proper examination and treatment at the port of disembarkation. The passing of the Destructive Insects and Pests Act of 1914 precludes the possibilities of such introductions now, but there is no measure by which seedlings or grafts from affected localities could be prevented from entering into localities which have hitherto remained immune. With demobilization and the end of the last great war, many people in North India are actively thinking of taking to fruit culture in the Himalayas, especially in Kulu and Kumaon, and such people should desist from obtaining their stocks or grafts from affected localities or else they will be put to considerable expense and loss in course of time.

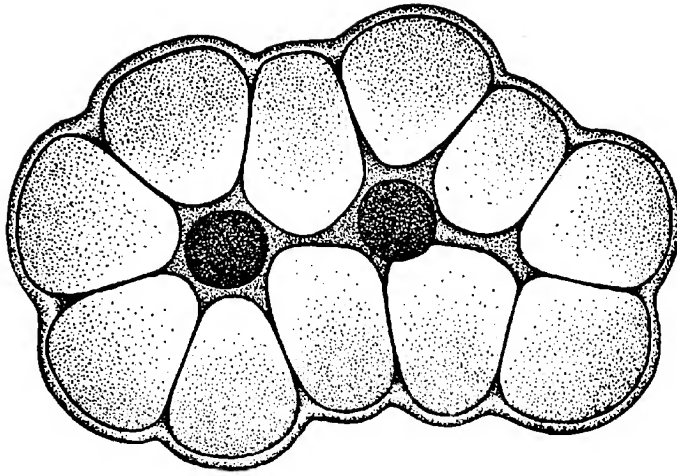
¹ Marchal, P. "Le cycle évolutif du Puceron lanigère du Pommier *Erio. lanigerum*." *Bull. C. R. hebdom. Acad. Sci., Paris*, CLXIX. No. 5, 4th Aug. 1919, pp. 211-216. *Rev. App. Ento.*, VII, A, 10, p. 432, Oct. 1919.

Baker, A. C. "The Woolly Aphis." *Rept. No. 101, U. S. Dept. Agri. Bureau of Entomology*, 1915.

Theobald, F. V. "Insect Pests of Fruit," pp. 141-153, 1909. *Monthly Bull. Cal. State Commiss. Hortic. Sacramento*, Vol. VI, Nos. 11-12, Nov. and Dec. 1917.

My main object in writing this short note has been to draw the attention of such would-be fruit-growers and they would do well to follow the brief recommendations made herein. For more detailed information they should consult the latest work done on the pest in England, America, Australia and South Africa. Of the two forms of the Aphid, that which lives on the roots of apple trees is the most difficult to deal with, but with experiment and observation the ravages of the subterranean form have been considerably lessened or altogether eliminated by grafting the selected but susceptible varieties on such resistant varieties of apple as the Majetin and the Northern Spy. The usual method in South Africa is first to graft a slip of resistant branch on to a resistant root and later to graft on this stock the particular variety of apple desired to propagate. To further the work of the establishment and selection of resistant stocks, observations from a number of places and on a number of varieties are required, and if the readers of this Journal will keep a record of their observations, as was done by Lt.-Col. Bernard Scott (*vide* his letter quoted above), considerable information will accumulate which will be of great use to prospective apple-growers in different parts of the country. They should particularly avoid planting affected stock which should be obtained from reliable nurserymen only. If, however, there are any doubts, the roots of plants should be opened and examined. If they are twisted, malformed or swollen, there is every reason to suspect that they are affected and as such should be condemned and burned. If, however, the affection is slight they should be thoroughly treated with kerosine emulsion or hot water before being planted out permanently in the orchard. Old and badly infested trees should be completely dug out and burned, and the space utilized for other crops for a series of years. If this is not done soon, there is every possibility of other trees becoming affected, and the whole orchard becoming, in course of time, a hotbed for the propagation of the pest and a source of danger to the adjoining apple orchards.

The aerial form is easily detected by the presence of bluish-white flocculent patches on the stems as seen in Plate XLI. This form can be easily controlled by spraying the infested trees with any of

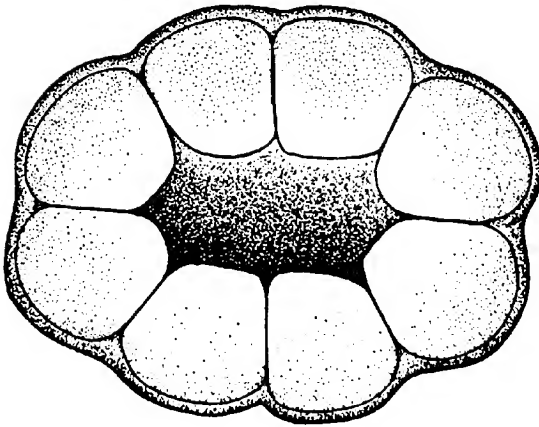


a.

Wax pores on the body of the Woolly Aphis, wingless viviparous form.

a. Dorso-thoracic wax pore, much enlarged.

b. Dorso-abdominal wax pore, much enlarged (original.)



a.

the contact insecticides, crude oil emulsion, kerosine emulsion, or fishoil resin soap. The flocculent bluish-white secretion which covers the bodies of nymphs, as well as the adults, is secreted from wax pores* interspersed on the body of the Aphid and possibly acts as a good insulator against inclemencies of weather and the dampness of the earth, especially in the case of the underground forms (Plate XLII). In order that the contact spray-fluid should come in immediate contact with the bodies of the Woolly Aphis, it is necessary that the spraying should be done persistently and with a force-pump provided with an air-chamber, so as to remove the bloom surrounding the bodies of the Aphid. To do this satisfactorily, an extra quantity of spray fluid should be used, and at frequent intervals, until no trace of the pest is left on the trees. The extra expenditure thus incurred will be more than counterbalanced by the good results obtained later on.

The use of tobacco has had a marked success in dealing with this serious pest. The tobacco destroys the Aphids by leaching through the soil and acts as a bar for a year or so to reinfestation. The dust is a waste product of tobacco factories and possesses the additional value of being fully worth its cost as a fertilizer.¹ In one of the latest works on the pest it is stated²:—"It was found that Black leaf 40, 1 part to 1,000 parts of water, poured into the soil around the roots practically freed the trees from the root-infesting form. The experiment was then tried of planting a plot with tobacco, the refuse from this growth being chopped up and placed in trenches around the fruit trees, 5 lb. being used for each tree. This was first applied in November and the rest towards the end of February; the second application seemed to be the most successful and an orchard badly attacked by *Eriosoma lanigerum* is now entirely free from infestation.....Though this treatment of

* Specimens treated with ammonia-ferrie-sulphate, stained with Delafield's hæmatoxylin, counterstained with eosin in absolute alcohol, cleared in cedarwood oil and mounted in Xylol Balsam.

¹ Circular No. 20, Revised edition, U. S. Dept. Agri. Bur. Entom., June 1903.

² "Rept. of County Hort. Commis." *Monthly Bull. Cal. State Commis. Lumm. Sacramento*, Vol. VI, Nos. 11 and 12, pp. 415-432, Nov. and Dec. 1917. *Rev. of Applied Entom.*, Vol. VI, A, 3, pp. 797-98, March 1918.

root-infesting forms of Aphids is still in the experimental stage, it is considered worthy of recommendation to growers."

If these preventive and remedial measures are adopted, it is hoped that the ravages of the pest will be minimized and circumscribed considerably. It will no longer lay a heavy toll on the yearly produce, and the main impediment to the extension of the budding apple industry in the Northern Himalayas will be removed completely. With the extended use of blight-resistant stocks, the dreaded pest will be brought within such control that, what Mr. French, the Government Entomologist of Victoria, wrote in 1904 will hold good more or less in this country also. He said¹:—"Before the advent of these excellent blight-resisting stocks, the Majetin and the Northern Spy, it was exceedingly difficult to find in most orchards an apple tree that was clean or in perfect health. Now, with a little care and attention, the fruit-grower, as a rule, may snap his fingers at the American-blight"

[*Note.* To the list of localities given by Mr. Misra as infected with this Aphid, may be added Shillong and Ramgarh (Kumaon District). Probably all apple-growing districts in India and Burma have been infected by means of the importation of diseased stock. As regards control, (1) in the case of newly imported stock, whether received from anywhere in or outside of India, it should be examined very carefully on receipt and before planting and, if there is the least sign of infection, the plants should be wiped over with an insecticide such as methylated spirits (used successfully in the Government Fruit Garden at Shillong); if the trees are badly infected, the best thing to do is to burn them forthwith. (2) In the case of orchards which are already infected, every endeavour should be made to keep the pest within control, by attacking it immediately it is seen and not allowing it to spread. If trees appear sickly without obvious cause, the presence of this Aphid may be suspected and the roots should be opened up and, if the

¹ French, C. "Destructive Insects of Victoria," Vol. I, p. 37, 1904.

Aphid is present, treated with a contact insecticide, and a good quantity of waste tobacco be placed around the roots. The aerial forms, living on the trunk and branches of the trees, should be treated with a contact spray or wash, thorough treatment being essential. Special endeavours should be made to check this pest at the time when the winged adults appear, in order to prevent these from spreading infection throughout the orchard. At Ramgarh I noticed the winged adults present about the third week of August 1918 and probably this date will hold good, approximately at least, throughout the Himalayan Region.—T. BAINBRIGGE FLETCHER, Imperial Entomologist.]

A PRELIMINARY NOTE ON THE EFFECT OF
WATERINGS ON THE AMOUNT OF ACIDS
SECRETED BY THE GRAMPLANT
(*CICER ARIETINUM*).*

BY

D. L. SAHASRABUDDHE, L.Ag., B.Sc.,
Assistant Professor of Chemistry, Agricultural College, Poona.

INTRODUCTORY.

It has long been known that the gram plant secretes and deposits an acid liquid all over its surface. This peculiar acid secretion was studied in some of its aspects by me some years ago and the results of that study were published in *Bulletin No. 45 of the Agricultural Research Institute, Pusa*, in 1914. The following conclusions were arrived at:—

- (1) The whole gram plant is covered with two kinds of hairs—simple and glandular. The glandular hairs with knobs are found in large proportion on the ovaries and the pods and the amount of acid produced by the parts covered with glandular hairs is far greater than the amount produced by the other parts of the plant.
- (2) When the plant is two weeks old, it is covered with the acid liquid equivalent to about 0.36 gramme of caustic potash per hundred grammes of dry matter of the plant and the acidity goes on increasing up to 3 or even 3.5 grammes of caustic potash when the pods are well developed but decreases when the plants begin to ripen.

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

- (3) The acids in the liquid consist of malic acid 90 to 96 per cent., oxalic acid 4 to 9 per cent., and volatile acids 0.1 to 0.5 per cent.
- (4) The plant is continually producing acid and if the plant is washed with water the usual acidity is recovered in about a week.
- (5) Lastly, about 2,000 grammes of malic acid could be collected from one acre of gram crop.

It was subsequently proposed to find out the effect of waterings and manures on the quantity of acid produced, and the following are the results arrived at from the pot experiments carried out at Poona.

THE EFFECT OF WATERINGS.

The experiments were carried out in glazed pots buried in the ground, the surface area of the soil in pots being 1.39 square feet. Soil sufficient to fill all the necessary pots was collected together and properly mixed in order to make it uniform for the pots. The pots were filled with the mixed soil with a gentle pressure and watered with one gallon of water per pot. The seed was sown when the moisture condition of the soil was favourable for sowing.* The seed was carefully selected to keep uniformity. There were in all 18 pots used. They were in six rows of three pots each and in each pot three seeds were sown on 23rd October, 1914. The seeds germinated on the 2nd of November and the waterings were started from that date, each watering being equal to 1,000 c. c. of water.†

The pots in the first row were watered every day, in the second row twice a week, in the third row once in a week, in the fourth row once in two weeks, in the fifth row once in four weeks, and in the sixth row the pots were never watered after the seed was sown. Out of three plants in each pot the weakest was removed and only two plants were kept so that for each experiment there were six plants available. The acidity was determined by pulling out the plants,

* 22 per cent. moisture.

† About $\frac{1}{2}$ inch of rainfall.

washing them completely with distilled water and titrating against $\frac{N}{10}$ caustic potash. The dry matter of the plant was also determined and the acidity expressed in terms of grammes of caustic potash. The acidity was determined when the pods were fully formed. It was proved in the *Pusa Bulletin* No. 45 that the highest amount of the acids was secreted when the pods were fully formed and hence the results of the determinations at this stage are important.

It might with advantage be mentioned here that the first row of pots received 64 waterings from the time of germination to the time when the pods were fully formed; the second row received 22 waterings, the third 10 waterings, the fourth 5 waterings, the fifth 3 and the sixth no watering after germination of the seed. The plants in the first row took longer to develop fully the pods. All the other plants had their pods fully developed between the 8th and the 15th of January, 1915, while the plants in the first row came to the same stage on the 12th of February. The following table gives the dry matter per plant and acidity per 100 grammes of dry matter in grammes of caustic potash.

TABLE I.

Dry matter and acidity at the time when the pods on the plants are fully developed.

	Dry matter per plant grammes	Acidity per 100 grammes of dry matter in grammes of caustic potash
1. Watered every day, 64 waterings ..	29.0	0.93
2. Watered twice a week, 22 waterings ..	14.8	1.60
3. Watered once a week, 10 waterings ..	9.6	1.86
4. Watered once in two weeks, 5 waterings ..	7.5	1.98
5. Watered once in four weeks, 3 waterings ..	10.2	2.15
6. Not watered	4.5	2.52

The first column shows that except in No. 5 there is increase in weight of dry matter as the number of waterings increases. In the first four rows of pots there is an increase of 0.38 gramme of dry matter per watering of 1,000 c.c. The figures in the second column show that the acidity per 100 grammes of dry matter decreases as the waterings are increased in number. One peculiarity is that as the

number of waterings increases the fall in acidity becomes smaller. The fall in acidity per cent. as seen between the plants that received 3 waterings and the plants that received 5 waterings is 0.085 gramme of caustic potash per watering of 1,000 c.c., while the fall between the plants that received 5 waterings and the plants that received 10 waterings is 0.024 gramme of caustic potash and so on, as will be clearly seen from the following table:—

TABLE II.

Fall in acidity per 100 grammes of dry matter for every watering of 1,000 c.c.

Plants					Fall in acidity per cent. in grammes of caustic potash
Between plants receiving	22 and 64 waterings	..	..	..	0.016
.. " " 10 " 22 "	..	..	..	..	0.022
.. " " 5 " 10 "	..	..	..	..	0.024
.. " " 3 " 5 "	..	..	..	..	0.085

Although the percentage of acidity decreases with the increase in the number of waterings, the actual quantity of acid secreted by each plant increases, as will be seen from the figures given below:—

TABLE III.

Total acids per plant.

Plants					Average total acids per plant in grammes of caustic potash
Watered 64 times	..	..	..	..	0.27
.. 22 "	..	..	..	..	0.24
.. 10 "	..	..	..	..	0.18
.. 5 "	..	..	..	..	0.15
.. 3 "	..	..	..	..	0.22
Not watered	..	..	..	..	0.11

We might, therefore, conclude that when the number of waterings is increased, the dry matter per plant and total acidity per plant are increased, while the percentage of acidity on dry matter is decreased.

MALFORMATION OF THE COTTON PLANT LEADING TO STERILITY.

BY

G. L. KOTTUR, B.Ag.,

AND

M. L. PATEL, B.Ag.,

Of the Department of Agriculture, Bombay.

IN almost all parts of Western India, with the exception of those growing American types of cotton, there appear occasional malformed cotton plants or parts of plants which either produce no flowers or bolls, or produce a few small bolls only giving light seed with low ginning percentage. The affection is so generally distributed and leads to such an appreciable annual loss that a close study of its nature and character has become essential. So far we can only describe the affection: its cause remains obscure. No parasite, either of animal or vegetable origin, has been noticed, and no means have been discovered for anticipating and checking its development.

The appearance of a malformed plant is very characteristic. Either the whole of the branches of a plant or certain among them only show three characteristic changes, generally commencing when the plants are two to three months old. These changes are as follows. The leaves become smaller and more cleanly cut, and do not possess the usual sinuses, and hence appear crowded together on the stem or the branches. The colour is also abnormal, the leaves being dark green at first, gradually changing to reddish and pinkish yellow as the stage of affection advances. And, again, the plants or branches affected usually die without producing any seed, though occasionally



1
Normal branch and leaf.



2
Malformed branch and leaves.



a few normal flowers are produced giving seed. Usually, however, though the cup-shaped calyx of the flower appears, the flower-bud does not develop and remains in a rudimentary condition.

As we have already stated, the whole plant may be affected, with most of the leaves pinkish yellow, bearing no flowers and bolls. Often, however, only one or more branches are affected, and the remaining portion develops normally. The malformed branches may produce small bolls, though most of them dry up rapidly and the few which succeed are often imperfect in opening and give produce of low ginning percentage and light seed. A third type of diseased plant is often noticed, where the whole appears healthy, except that at the base there is a clump of short branches having the malformed diminutive leaves.

The appearance of plants affected with the disease in question is very characteristic. Plate XLIII shows a branch and leaves of such a plant, side by side with a normal cotton branch of the same variety, and when (as has sometimes happened) more than eight per cent. of the plants in a plot are affected the matter becomes of very serious importance.

Among the various types of cotton, it may be stated at once that the disease has never been noticed among American or Egyptian varieties. Among indigenous Indian cottons, the *herbaceum* cottons (Broach, Goghari, Kumpta, etc.) are by far the worst affected, but the other types (*neglectum* and *obtusifolium*) also show the affection though to a limited extent. Among the *herbaceum* cottons, Surtee-Broach and Goghari are more affected than Wagad. In the former a large proportion as 17 or even 19 per cent. has been noticed. In 1915, at Dharwar, careful examinations were made and it was found that 19 per cent. of Goghari plants were affected, and 15 per cent. of Broach, while only two per cent. of Kumpta showed the characteristic malformation. This was a very bad year, however, and in the last season (1919-20) not more than 0.1 per cent. of the Kumpta plants were affected by the disease.

The malformation is also affected by season, though exactly in what way is not quite clear. In general, it may be said that a light rainfall, with long breaks between the rain, seems to favour its

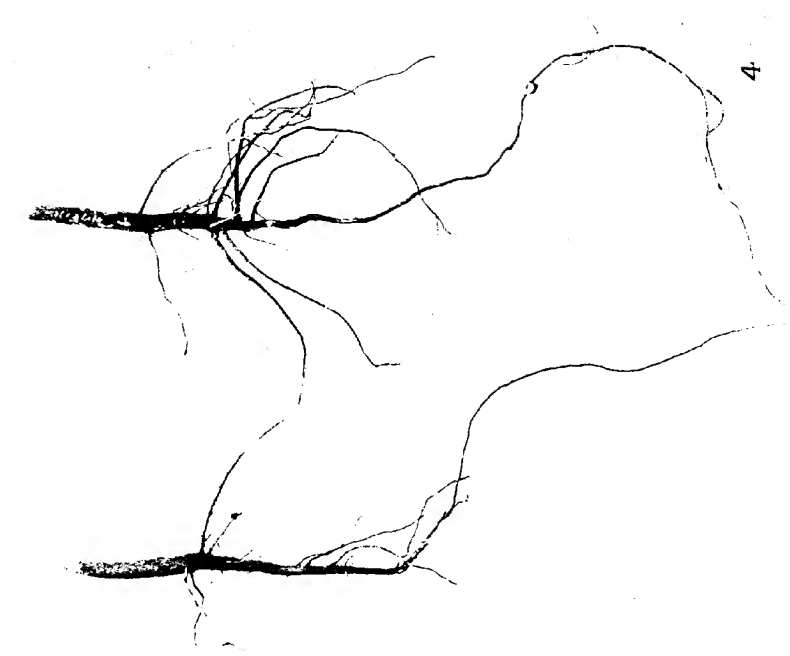
development. The following table for several seasons at the Surat Farm shows the effect of season, and also the extent of difference between different plots in the same year.

Year	PERCENTAGE OF AFFECTED PLANTS		Seasonal remarks
	Highest	Lowest	
1914-15 ..	1.5	1.0	Heavy rainfall with slight breaks.
1915-16 ..	8.5	4.1	A drought year, short period of rainfall followed by long breaks, with late rains.
1916-17 ..	7.0	1.0	A heavy rainfall year. The season started with light falls with one long break of 3 weeks.
1917-18 ..	1.6	nil	A very heavy rainfall year.
1918-19 ..	4.2	2.0	A drought year, stormy heavy fall in the beginning, followed by light falls, the rains stopping very early.

Among other observations at Surat, as to the conditions affecting the disease, it may be remarked that where cotton seed is dibbled before the rain comes, the resulting plants seem more affected than those sown immediately after the rains break, and that late-sown cottons seem to be least affected.

There is no evidence that the malformation is hereditary. The seeds obtained from the healthy branches in malformed plants, or even the few seeds from the malformed branches themselves were sown, but the affection did not appear at all either in the first or second generation of self-fertilized flowers at Dharwar. At Surat, where larger tests were made, there was an imperceptible difference in the attack of the disease when seed from healthy or malformed plants were taken. Where selection has gone on for fifteen years in cotton, the seed of affected plants being rejected each year, there is a very slight reduction in the proportion of attack at Surat.

At Surat, in plots very highly manured with night soil, the affection has been less than on the rest of the farm. It has, on the other hand, been greater in cotton grown without rotation, than when other crops like *jowar* (*Andropogon Sorghum*) are taken in the alternate years. In rotated cotton, apparently cotton coming after *til*



(*Sesunum indicum*), *tur* (*Cajanus indicus*) or groundnut, is more affected than when it comes after *jowar* (*Andropogon Sorghum*). Again, land ploughed thoroughly with an iron plough contained more affected plants than land which had not been ploughed, and again land of a slightly saltish character or where brackish irrigation water has been used seems to produce a larger proportion of affected plants. This is in accordance with observations elsewhere. Finally, ratoon plants, that is to say plants allowed to grow up again after cutting down the cotton stalks, give a considerably greater proportion of malformation than the original crop.

The plants show, as already stated, no sign of an animal or vegetable parasite. This has been the result of examinations made in Pusa (1916-17) and in Poona on several occasions.

The malformation seems to be connected with a change in the root development, which is illustrated in the attached figures. When the affected plants are uprooted, the main tap root in totally malformed plants seems to have abruptly ended giving a number of secondary roots (Plate XLV, fig. 1 A and B). In partially affected plants the root system seems very much weaker and less extensive than is normally the case (Plate XLV, fig. 1 C and D). When, however, the affection only results in a malformed bunch of leaves at the base, or when only the secondary growth from the stubbles is malformed, then the root system is normal (Plate XLV, fig. 2). On the whole a diseased plant seems much more easily uprooted than a healthy one.

At present it is quite impossible to suggest a cause for this disease or a method of treatment. The fact that non-rotated cotton is highly affected and that saltish land seems to induce the disease, may, perhaps, give the clue to a method of prevention. But further investigation is needed and is going on, and the present note is only published to draw the attention of workers on cotton to the disease, and to induce further observations on what is undoubtedly a very important hindrance to cotton growing at least in Gujarat and the Bombay Karnatak.

THE CHEMICAL AND BIOLOGICAL ASPECT OF
BHATA SOIL, OF CHANDKHURI EXPERI-
MENTAL FARM, CENTRAL
PROVINCES.*

BY

A. R. PADMANABHA AIYER, B.A.,
Offg. Agricultural Chemist, Central Provinces,

AND

D. V. BAL, L.Ag.,
Bacteriological Assistant, Department of Agriculture, Central Provinces.

INTRODUCTION.

IN the Central Provinces there are large areas of lateritic soil called *bhata*, most of which is lying waste at present and is considered to be too poor for general cultivation. Experiments conducted at Chandkhuri Farm show that the cultivation of various crops is economically possible on such soil, the details of which were given in a paper¹ read at the Indian Science Congress at Lahore in 1918, by Messrs. Clouston and Aiyer.

It was brought to the notice of the Agricultural Chemist that sann-hemp was not making satisfactory growth in this class of soil at Chandkhuri Farm, which is situated in Chattisgarh, Central Provinces, about 16 miles from Raipur. Samples of soil were, therefore, taken to Nagpur where pot culture experiments and other investigations were undertaken.

* Paper read at the Seventh Indian Science Congress, Nagpur, 1920.

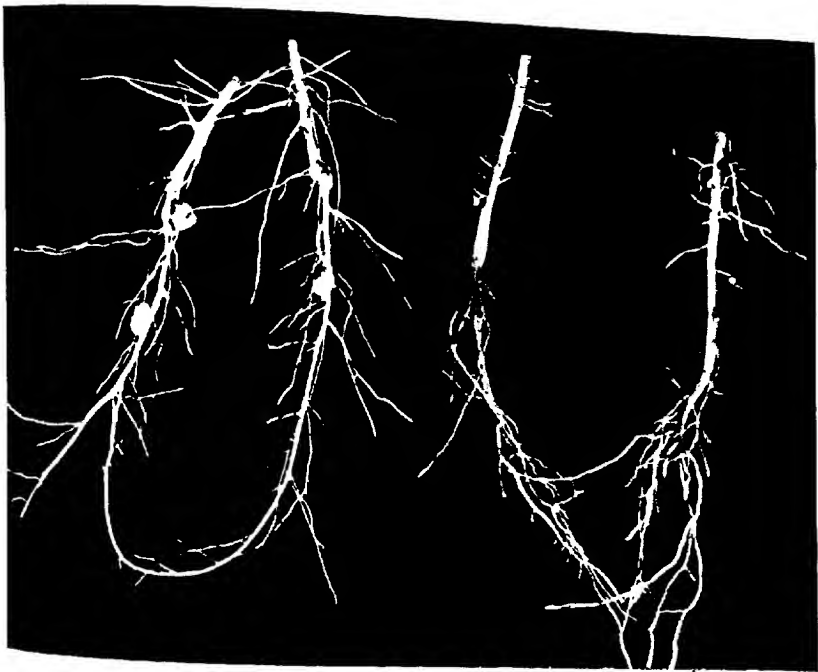
¹ *The Agricultural Journal of India*, Special Indian Science Congress Numbers 1918.



Black cotton soil.

Fig. 1.

Bhata soil.

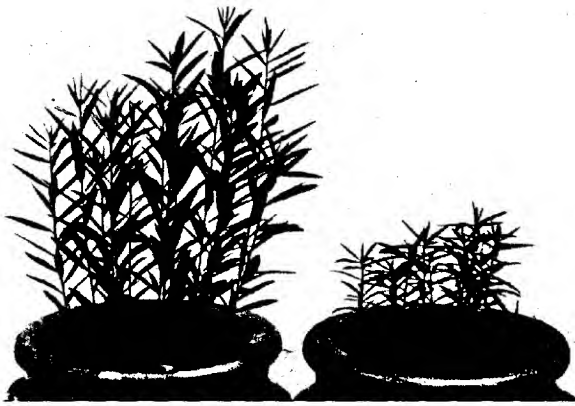


Black cotton soil.

Fig. 2.

Bhata soil.

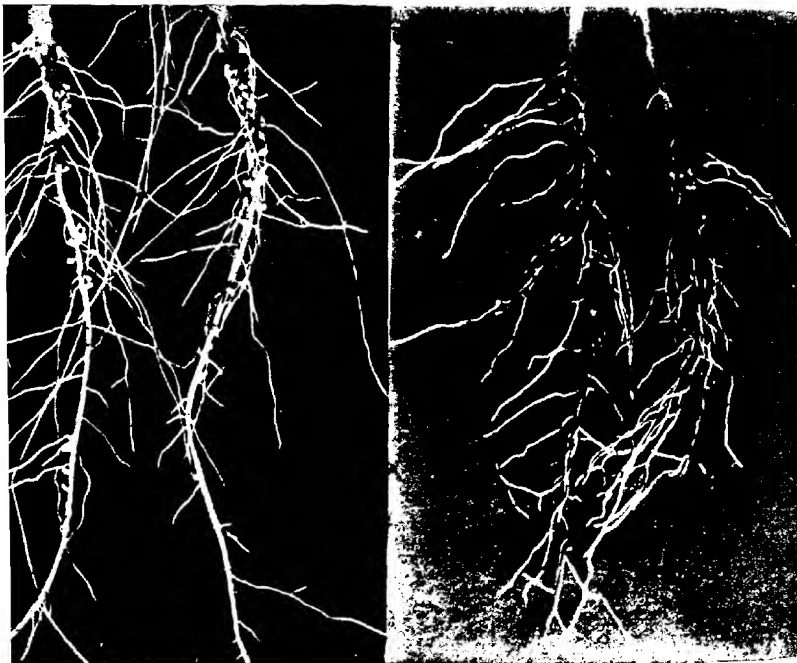
DHAINCHA (*SESBANIA ACULEATA*).



Black cotton soil.

Bhata soil.

Fig. 1.



Black cotton soil.

Bhata soil.

Fig. 2.
SANN-HEMP.

EXPERIMENTAL.

Physical and chemical analyses of the soil were first carried out and the figures obtained are tabulated below. It may be mentioned here that there is no uniformity in the methods adopted for the interpretation of the results of analyses. The following are some of the methods commonly used:—

- (1) The analytical figures are expressed as percentages on air dry fine soil below 1 mm.
- (2) The results are sometimes expressed as percentages on the original air dry soil.
- (3) Proportions of the various ingredients are expressed as lb. per acre up to a depth of either 8·9 or 12 inches depending upon the nature and depth of soil.

Of the methods mentioned above, No. 1 is commonly used in most of the agricultural laboratories. Figures expressed according to this method would be comparable only when the different soils under comparison contain a small proportion of stones and gravel. But as the *bhata* soil contains an unusually high proportion of stones and gravel, such a representation might be quite misleading. The analytical figures are, therefore, represented as percentages on the original soil and as lb. per acre. The figures of black cotton soil are also given for comparison.

TABLE I.

Showing the physical and chemical analyses of bhata and black cotton soils.

				% on original soil	
				<i>Bhata</i> soil	Black cotton soil
Stones and gravel	..	..	..	68·00	10·00
Coarse sand	..	..	..	9·53	9·17
Fine sand	..	..	..	5·21	6·66
Silt	..	..	..	6·02	11·29
Fine silt	..	..	..	3·84	17·67
Clay	..	..	..	3·71	33·27
Moisture	..	..	..	0·70	3·00
Loss on ignition	..	..	..	1·77	2·72
Calcium carbonate	..	..	..	0·08	1·41
TOTAL				99·86	100·24

	% on original soil	
	Bhata soil	Black cotton soil
Nitrogen	0.024	0.030
Total phosphoric acid	0.019	0.180
Available do.	traces	0.008
Total potash	0.264	0.770
Available potash	0.050	0.041
Calcium carbonate	0.080	1.440
Organic carbon	0.163	0.220

TABLE II.

Showing the chemical composition in terms of lb. per acre up to a depth of 8 inches.

	Bhata soil	Black cotton soil Nagpur
Nitrogen	648.2	1097.7
Total phosphoric acid	513.2	6586.3
Available do.	traces	292.7
Total potash	7129.9	28284.6
Available potash	1350.4	1500.2
Calcium carbonate	2160.6	52690.2
Weight of a cubic foot of soil up to a depth of 8 inches	62	84
Weight of soil per acre to a depth of 8 inches	27,00,720	36,59,040

From the foregoing figures of analyses it will be seen that this soil contains a very low proportion of fine material, in fact, only about 7.5 per cent. Within the range of action of a plant's roots there is a deficiency in phosphoric acid and lime.

EXPERIMENTS ON LEGUMINOUS CROPS.

Since sann-hemp was not making satisfactory growth on this soil various other legumes were also tried in pots containing *bhata* soil. For comparison, pots of black cotton soil from Nagpur Farm with the same legumes were grown alongside, as this class of plants is known to make good growth in black cotton soil.

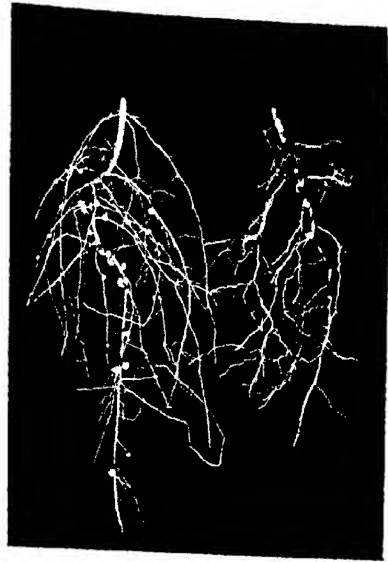
It was found in every case that the plants in black cotton soil made a much better growth than those in *bhata*, inspite of the fact that the latter is a more open soil. For the relative growth of *dhalincha* (*Sesbania aculeata*) and sann-hemp see Plate XLVI, fig. 1, and Plate XLVII, fig. 1.



Black soil.

Bhata soil.

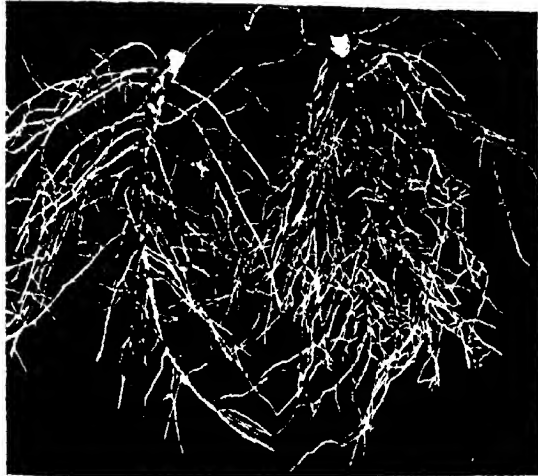
Fig. 1. *Cajanus indicus*.



Black soil.

Bhata soil.

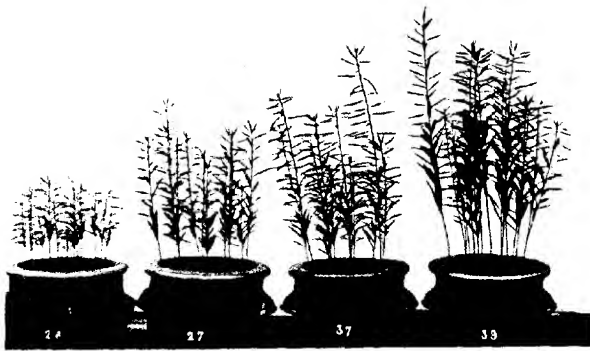
Fig. 2. Cowpea.



Black soil.

Bhata soil.

Fig. 3. Groundnut.



Control Inoculated Cake Cake and Inoculation

Fig. 1.



Control Lime Super Super and Lime.

Fig. 2.



Control Super Super and Lime Basic Slag.

Fig. 3.

SANN-HEMP IN BHATA SOIL.

In order to find out whether there was any relationship between the plant growth and root development, the latter was first studied. From Plate XLVI, fig. 2; Plate XLVII, fig. 2; and Pl. XLVIII, it will be seen that with the exception of groundnut all other leguminous plants grown in black cotton soil showed a much larger root and nodule development than those grown in *bhata* soil. It may be remarked that this farm had been growing groundnut for two to three years before the sample of soil was taken and probably by that time the crop must have become adapted to the soil.

In view of these observations, in the following season *bhata* soil was inoculated with an emulsion of black cotton soil and sann-hemp was again grown. This gave a very decided increase in the growth of the sann-hemp crop (Plate XLIX, fig. 1).

In order to determine further whether poverty in growth was due to lack of plant food, manurial experiments were also tried. The manures lime, super, super and lime, basic slag and til (*sesamum*) cake were employed to supply lime, phosphoric acid, organic matter and nitrogen.

A striking result noticed was that super gave an immediate return in the form of increased weight. Lime, when used alone, had a depressing effect and had no advantage when used in conjunction with super (Plate XLIX, fig. 2). Basic slag gave a slight increase in crop growth (Plate XLIX, fig. 3). The effect of cake was distinctly marked, showing need of the soil for manures of this type (Plate XLIX, fig. 1).

A very striking result was, however, produced when cake was applied to the *bhata* soil and the latter was inoculated with an emulsion of the black cotton soil. It was observed that the plants from these pots were the best of the whole series both from the point of general growth and root and nodule development (Plate XLIX, fig. 1). This fact would indicate that the *bhata* soil is not only deficient in nodule forming organisms, but is also probably deficient in organisms associated with the decomposition of organic matter. This deficiency may be either in kind or number. The average relative heights and weights of sann-hemp plants from the various pots are shown in Plate L.

In order to obtain some idea of the biological activities of the soil the usual biological examination was carried out. Instead of giving the details of all the biological experiments, only those that are of more importance and of interesting nature are given below.

AMMONIFICATION IN REMY'S SOLUTION.

100 c.c. Remy's solution was inoculated with 1 grm. of soil. For comparison the ordinary black cotton soil was also started side by side.

TABLE III.

Showing in milligrams nitrogen ammonified.

				After 24 hours	After 48 hours	After 3 days	After 7 days
<i>Bhata</i> soil	..	..	..	15.4	45.5	77.98	98.35
Black cotton soil	..	..	..	2.8	9.2	31.70	82.00

The results show that this soil has quite satisfactory ammonifying power and this fact is further corroborated by the following experiments.

AMMONIFICATION AND NITRIFICATION.

Oil-free *til* cake supplying 60 mgm. nitrogen per 100 grm. of the soil was employed and water equal to $\frac{1}{2}$ saturation was added.

TABLE IV.

Showing % nitrogen ammonified and nitrified.

	AFTER 2 WEEKS		AFTER 4 WEEKS		AFTER 6 WEEKS		AFTER 8 WEEKS	
	% N as NH ₃	Total % N nitrified	% N as NH ₃	Total % N nitrified	% N as NH ₃	Total % N nitrified	% N as NH ₃	Total % N nitrified
<i>Bhata</i> soil sampled through 1 mm. sieve ..	85.86	0.085	48.5	23.90	27.0	42.7	25.2	59.7
<i>Bhata</i> soil original including stones and gravel ..	87.70	0.000	74.6	7.85	42.0	19.2	46.6	32.0
Black cotton soil ..	24.10	9.000	9.6	45.00	2.3	65.5	..	70.0 to 85.0

The total % N nitrified referred to in the above table includes both nitrite and nitrate nitrogen.

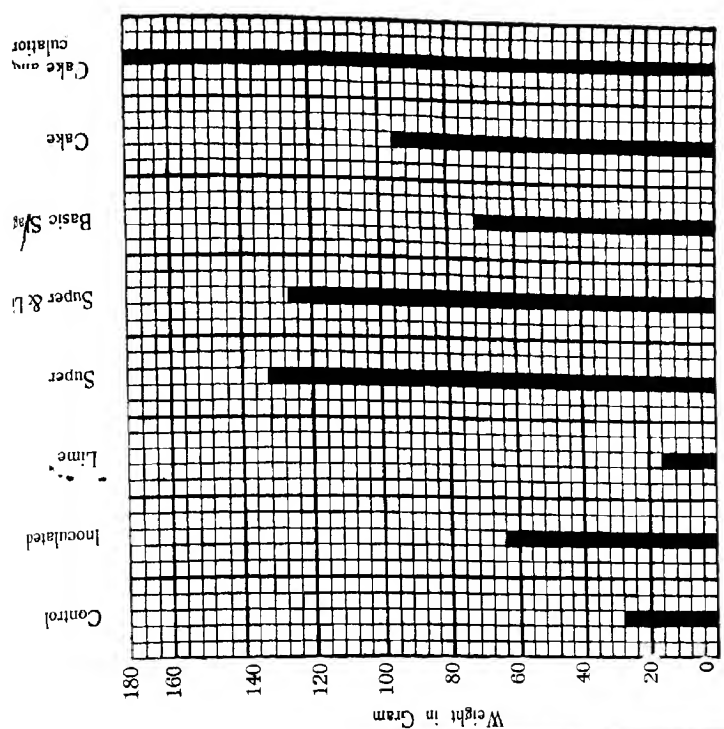


Fig. 2. Showing the average weight of green Sann-hemp plants from duplicate pots of Bhata soil.
(Number of plants in each pot, 14.)

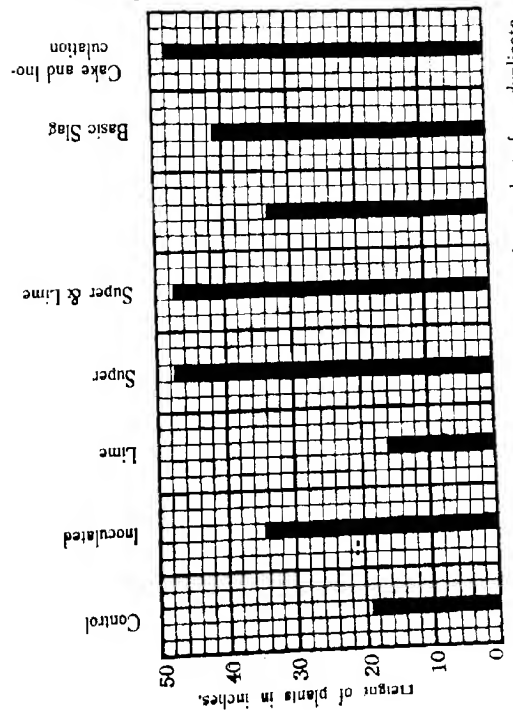


Fig. 1. Showing the average height of Sann-hemp plants from duplicate pots of Bhata soil.

These results show that the ammonifying power is quite good and that the nitrification, though not as good as in black cotton soil, can be called average. The difference in nitrification in the sampled and the original soil is quite striking and may be explained by the increased soil surface present in the finer grained sampled soil.

NITROGEN FIXATION.

Nitrogen fixation, as found out from Ashby's mannite solution, appears to be weak. *Bhata* soil fixes about 4.5 mgm. of nitrogen per gram of mannite as against 9 to 10 mgm. fixed by black cotton soil.

The bacterial content of the soil increases rapidly when organic manures are added. In a sample of *bhata* soil taken from an unmanured area from Chandkhuri Farm, the average number of bacteria found was about 0.9 million per gram of soil, whereas in case of soil taken from a plot manured with cake and cattle dung the number was practically double, i.e., 1.7 millions per gram of soil.

We have to acknowledge the assistance and advice given from time to time by Mr. F. J. Plymen, now Deputy Director of Agriculture, Western Circle, Central Provinces, in starting and developing these experiments.

SUMMARY.

(1) Chemical, physical and biological analyses of the *bhata* soil were carried out. It is deficient in fine particles and contains about 69 per cent. of stones.

(2) Experiments conducted show that *bhata* soil responds to manuring with phosphoric acid and organic matter.

(3) It contains the necessary micro flora required for ammonification and nitrification and has also got the advantage of aeration and drainage due to its porous physical constitution.

(4) The poor growth of leguminous crops in the newly cultivated *bhata* soil appears to be due to want of phosphoric acid and a scanty formation of nodules.

(5) This latter defect is naturally removed to a great extent by continuous cropping. When the soil is to be newly cropped with legumes it can be successfully assisted by the application of cake and inoculation.

Selected Articles

THE GROWTH OF THE SUGARCANE.*

BY

C. A. BARBER, C.I.E., Sc.D., F.L.S.

V.

It is well known that different varieties of sugarcane ripen at different times even when planted together, and this has recently become an important factor in milling, as by a careful combination of varieties the season during which matured canes can be obtained is lengthened. Some interesting work has been done on this subject by Somers Taylor¹ with the canes growing in the Bihar sugar tracts of North India. He had as material local canes belonging to the earliest and latest in India, namely, varieties of the *Saretha* and *Mungo* groups. He found that when planted at the same time, good sweet juice was obtained from *Khari* as early as in December, whereas in several members of the *Mungo* group the canes were quite unripe at that date. These latter varieties could only be harvested profitably in March, while the best time to cut *Khari* was during January and February. The same kind of thing is known in many thick canes, but our knowledge is far from complete and it is highly desirable that more accurate information should be recorded than the casual observations at present available.

But even with a certain amount of knowledge as to the period at which a cane may be expected to mature it has often been found difficult to tell exactly when it is best to cut it. This is, because, the

* Reprinted from the *International Sugar Journal*, April 1920.

¹ Woodhouse, Basu and Taylor. "The distinguishing characters of sugarcane cultivated at Sabour. *Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. VII, No. 2, April 1915.

multitude of canes brought into the mill vary a great deal among themselves, some being just ripe, and others over or under matured as far as the richness of the juice is concerned. This variation in canes of the same kind we may readily imagine to be due to the fact that the canes of a bunch are not of equal age, as we have seen in our last paper.¹ The canes developed in succession, the *a*'s, *b*'s, *c*'s, etc. ripen one after another, and it becomes of some importance to know the true formula of a particular kind, in order to see which of these orders of branches is present in the greatest number. If the *b*'s are the most numerous, then it will be advisable to cut the canes after the *a*'s have somewhat passed their maturity, and if the *c*'s are present in larger numbers, then it would be advisable to concentrate on their ripening period, and so on. But it is unsafe to judge entirely by numbers, for, as we shall see, the canes of different orders of branching differ very markedly in their weight, their total length and the length and thickness of their joints, and also in the rapidity with which they mature. These differences in appearance will, however, be of use if we wish, at the mill, to pick out the branches of different ages and submit them to a more detailed chemical study.

In the first place let us consider the rate of maturing of the cane plant as a whole. It can be seen by anyone passing along the rows of canes growing in a trial plot that some, at three or four months of age, are habitually more forward than others in forming cane. It is usual to judge of this by the first formation of naked joints near the ground which have the normal thickness of the variety; but this is rendered difficult in some kinds by the close envelopment of leaves, which sometimes remain attached during the whole life of the plant. This is the case with most Indian varieties and, to make accurate comparisons, it is desirable to take out and clean the plants and make dissections to show their branching systems. During 1916 to 1918 some 350 plants were thus dissected at the Cane-breeding Station at Coimbatore, when from three to four months old. As the formation of canes is extremely rapid at this

¹ *Agricultural Journal of India*, September 1920.

period and the dissection took a very appreciable time, the subsequent comparison became extremely difficult. It is not proposed here to mention in detail these and other difficulties which were met with, nor the means adopted to overcome them, but merely to give in general terms the result of the study. This will be seen from the following statement, in which the various groups are placed in order of development :—

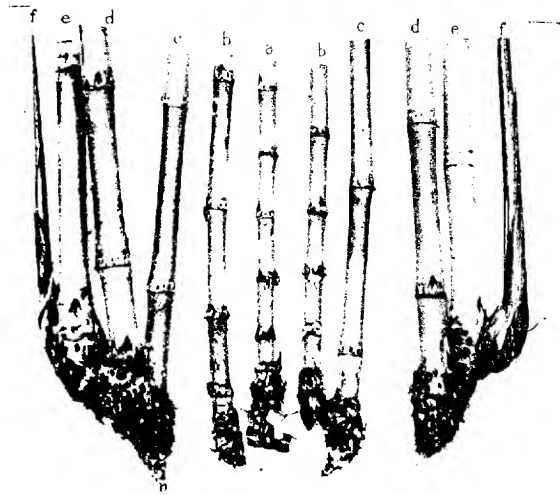
Early maturing : *Saretha* (brown), *Nargori*, *Pansahi*, *Saretha* (as a whole), *Sunnabile* (Dhau section), *Mungo* (only *Kharri*);

Moderately early : *Saretha* (green section), *Saccharum spontaneum*, thick tropical canes ;

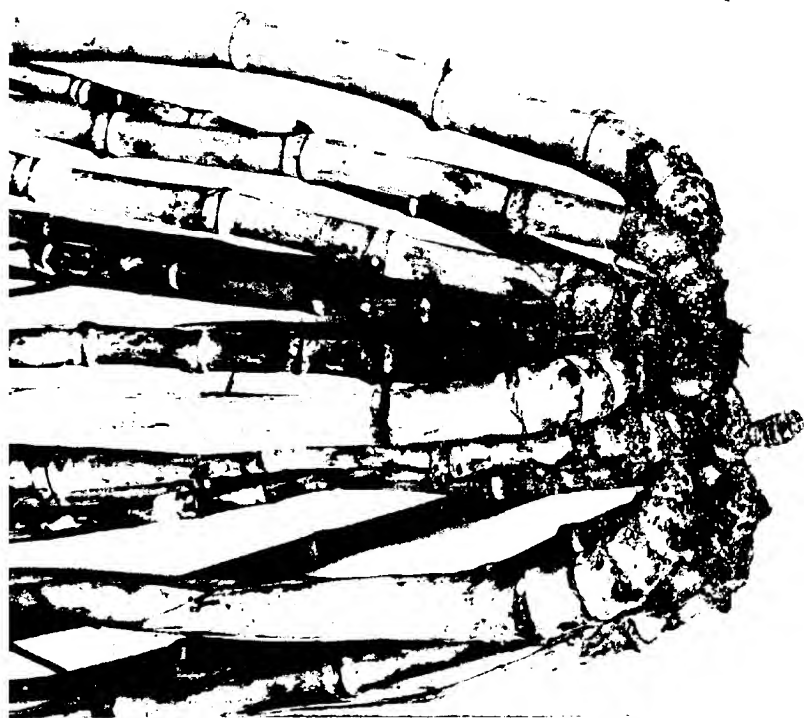
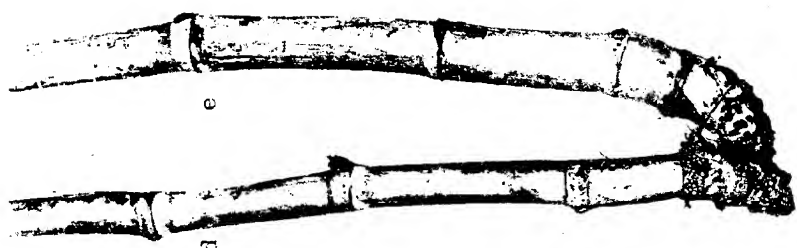
Late maturing : *Sunnabile* (as a whole), *Mungo* (as a whole), *Mungo* (without Dhau section), *Sunnabile* (Dhor section).

It is extremely desirable that similar lists, founded on careful observations, should be compiled of the rate of cane formation in comparative varietal plots. The kinds that really matter in such plots are generally few in number, and the work could be done each year in a much shorter time than that done at Coimbatore, thus ruling out the difficulties which were met with there.

The study of the differences between the branches of different orders, namely, the *a*'s, *b*'s, *c*'s, etc., was also a difficult piece of work. It had long been felt that such a study was needed, because of the occasional observation, especially in certain varieties, of those thick, late-formed shoots, called "gourmandizers," which usually had little sugar in them at crop time. But a final decision was arrived at, when it was found out that the canes in each bunch were not uniform and in fact differed so much among themselves that the current method of sampling a plot of canes was likely to introduce serious errors. Thus, when picking out 20 canes at random for measuring, it was easy, in certain varieties, to separate them into different classes which on examination turned out to be of early and late formation. The former were longer and thinner, had more and shorter joints, and had apparently richer juice. In our study of seedling canes these differences among the canes of different ages in the same plant were found to be much more pronounced. The colour often varied with the age from green or yellow to grey or



Branches of different orders in the dissection of *Saccharum arundinaceum*.
 The main stem, *a*, is in the centre, and *bs*, *cs*, *ds*, *es*, and *fs* are
 arranged on each side, passing outwards from the middle.
 The characters of these branches are as in Plate LII.



even purple, the thickness was sometimes three times as great in the later canes and the proportion of rooting and general habit differed quite as much. It soon became necessary to lay down rules as to which canes in the bunch should be selected as typical of the seedling, both as to its external form and the richness of its juice. When, therefore, the dissection work was taken up on a large scale, a series of measurements of each and every cane was introduced, from which to learn something of the meaning as well as the persistence of these differences. The results have fully justified the enormous amount of labour involved.

In the plants of *Saccharum arundinaceum* and *Pansahi* shown on Plates LI and LII some of these differences are very clearly shown; it is at once obvious that the *a*'s, *b*'s, *c*'s, etc., vary greatly in certain characters. Among the characters chosen for special study were the rate of cane formation, the thickness and length of the canes, the shape of the cane, and the amount of curvature of the base, the amount of rooting and shooting, the richness of the juice and so on. Averages have been struck in all the canes of the same order of branching, in each plant, clump, variety and group, as well as the whole series dissected, and some of the results are given briefly below.

(1) *Rate of early development.* Included in this term is the period between the shooting of the bud and the completion of the thickening of the cane, after which it proceeds to add joint to joint as the leafy shoot is thrust into the air. The region concerned consists of short, disc-like, superposed joints which gradually become thicker and longer, and, after some study, it was decided to limit it upwards by the first joint which had reached one inch in length. After this the thickness did not appear to vary much and the joints quickly assumed their usual length. The length of this basal, preparatory portion of the cane was carefully measured in each and every cane of the hundreds of plants dissected, and the results were tabulated and averaged. It was found that the *a*'s, that is the main shoots, were much the slowest in development. This is indeed not to be wondered at, when we consider the quantity of roots and leaves at the disposal of the plant at this period. The main branches

(b's), on the other hand, starting from a ready formed cane with larger equipment of root and leaf, went through their preparatory period much more rapidly, and this rate of development was seen to increase in subsequent orders of branching. But the matter soon became complicated by the fact that the later branches had to place themselves further from the centre of the plant for free growth, thus introducing a curvature at the base which is not seen in the a's or generally the b's. This curving region increases with the order of branching and mere measurements of the length of the basal portion were insufficient to demonstrate the rate of development. This fact must be taken into consideration in the figures that follow. The average length of the basal portion in all the a's and b's measured was 3.7 and 2.6 inches respectively. Taking only the *Saretha* and *Pansahi* groups of Indian canes and the six thick tropical canes we have the following averages (in inches):—

				a	b	c	d	e
<i>Saretha</i> group	..	..	..	3.4	1.7	2.0	2.4	(2.0)
<i>Pansahi</i> group	..	..	..	3.1	2.0	2.1	2.5	2.3
Thick canes	..	..	..	2.8	2.4	2.8	(3.8)	..

The figures in brackets being founded on an insufficient number of measurements for accurate determination.

(2) *Average length and thickness of the mature joints.* The measurements in joint length were commenced after the basal part had been passed, that is, after joints one inch in length had been reached; the thickness was taken of the cane at two feet from the base. The differences in these respects of the branches of different orders are very well seen in the Plates, and it is merely necessary here to record the averages of the actual measurements taken. As has already been stated, the observation of such phenomena has always been found much easier in the *Pansahi* group of canes and in the wild *Saccharum arundinaceum*, and these have been selected for reproduction, because they show the differences so well. Averages are also added for the *Saretha* group and for the six thick cane varieties dissected. There is much more variation in these, and no individuals if figured would be likely to present the matter in so striking a manner; but by the averaging of a very large number of

measurements in each (usually many thousands) these irregularities have been ruled out and they fall well enough into line:—

*Average length of matured joints above the basal part,
in inches.*

				a	b	c	d
Saretha group	2.2	2.8	3.3
Pansahi group	2.1	2.8	3.3
Thick canes	1.8	2.4	2.8

Average thickness of cane at two feet from the base in cm.

				a	b	c	d	e
Saretha group	..	..	..	1.59	1.66	1.78	1.92	2.04
Pansahi group	..	..	..	1.66	1.66	1.88	2.23	2.84
Thick canes	..	..	..	2.53	2.82	2.90	3.45	..

(3) *Richness of juice in branches of different ages.* This has been the subject of repeated study in the *Pansahi* group of canes, where the cut canes can be so readily divided into early (*a*'s and *b*'s) and late (*c*'s and *d*'s), and the results are very interesting. Two sets of analyses are given, which were made in 1916-17 and in 1917-18.

Sucrose in the juice of members of the Pansahi group.

			Per cent.	Per cent.
1916-17	..	<i>Maneria</i> (one clump) : early canes	.. 11.30	late canes 9.52
	..	Ditto (whole row)	.. 10.29	7.24
	..	Yuba (6 canes each from one clump)	.. 10.61	7.94
			Per cent.	Per cent.
1917-18	..	<i>Maneria</i> : very early canes	.. 16.90	early 16.40 to 16.48 late 13.99
	..	Yuba	.. 17.81	.. 17.17 to 17.77 .. 16.13

From these examples we see that, in the samples taken, the earlier or older the canes the richer the juice, and it would be interesting to compare these results with analyses taken at other places, especially as the sucrose content of the members of the *Pansahi* group appear to have so much richer juice in other tropical countries than in India. Thus far we have failed to establish similar relations of the juice richness in other groups of canes, possibly, because of the fewness of the observations and the irregularities in such groups.

From these and other facts elicited regarding the character of the juice in canes of different ages and in the different joints of

cane during its growth, we have been led to a certain conception as to what goes on in the ripening cane, as of influence on the behaviour at the mill, and it may be of interest to place it on record. The cane plant commences in a small way and, at first, is only capable of small things. But, as it gets bigger, has more roots which penetrate deeper into the soil and has larger and more numerous leaves wherewith to obtain food from the atmosphere, its capacity increases and greater numbers of thicker canes are produced. Each cane, as it reaches its appropriate thickness, proceeds to grow in length, but its joints, being at first young and tender, are filled with sap devoted to the building up of fresh tissue. But as the tuft of leaves is pushed into the air by the formation of new joints, one for each leaf, the older joints become less intimately connected with tissue formation. They become more mature and their large central cells become inert and charged with cane sugar, while the more actively living tissues are limited to a narrow external band, whose main function is the transmission of food from the roots to the shoot. When all but the uppermost joints reach this later stage, the cane is said to be mature and is ready for cutting. It does not seem likely that anyone will quarrel with this conception of the sequence of events.

We have seen that the canes of a bunch arise in succession, first the mother shoots from the buds on the set, then the branches of the first order and, later, those of the second, third and other orders, according to the system of branching as determined by the formula. A study of the dissections shows that there is usually a considerable period between the appearance of the first and last canes of each plant. In all of these the same sequence of changes may be assumed to take place in the contents of the joints, and thus there will be considerable differences in the times at which the different canes arrive at maturity and are fit for the mill. We have some reason then to suppose that the canes at crop time will not be equally matured, unless indeed no further change takes place in the canes after they have reached maturity. But there are abundant signs that such a change does take place, although it appears to differ in extent and rapidity under special local conditions and in different kinds of cane. There are in fact evidences that, after a

cane has matured, if left uncut, a process of deterioration sets in, the main result of which is that the purity of the juice and the quantity of sucrose in it decreases. The causes which induce this change in the stored sucrose in the large cells of the joints need not concern us here. The following analyses will illustrate our point. They were made at the same time as those of *Maneria* and *Yuba* quoted above in 1917-18. It was, at the time, recorded that the tops of these canes had withered because of drought, but the analyses were made just the same to see what the effect of this premature maturing would have on the juice.

Sucrose in the juice.

	Per cent.	Per cent.	Per cent.
1917-18 .. <i>Pansahi</i> : Very early canes ..	13.58	early 15.88 to 16.28	late 13.66
<i>Sada Khajee</i> : ..	15.82	16.58 to 17.84	

From these facts we learn that in each cane there will be a gradual rise in the quantity of sugar in it until an optimum is reached, after which there will probably be a more rapid decline in its content of this substance. If we take a milling period of one hundred days and assume that but one kind of cane is grown, all of it planted at the same time, we should in practice be most of the time cutting many canes which are not by any means at their optimum as regards sugar content. We should commence with the cutting when the mother canes are ripe, but their branches would be increasingly unripe, the higher the order of branching and the later they had risen in the bunch. Then, when the mother canes were a little past their prime, the *b*'s would be at their optimum, but the *c*'s and *d*'s would still be unripe; lastly, when the latter canes became fit for the mill the mother canes would be much deteriorated and the *b*'s would also have passed their optimum of sugar content.

The best time to reap a crop will be when the greatest weight of canes is mature; this will depend on the formula, and will, for instance, be very different for *Yuba* and B.208, and probably for Red Mauritius as compared with either. The formulæ tend to be symmetrical on each side of a certain order of branching, and if the system is small there will be most *b*'s, if large most *c*'s; but it is to be remembered

that not only the number, but the individual weight of the canes, has to be considered and this is invariably greater in the *c*'s than the *b*'s. It will be seen that there is plenty of scope for study in this matter, and it would be well, in the selection of early and late maturing canes, which will be necessary to extend the milling season to as great a length as possible, also to consider the optimum ripening of the canes of different orders of branching. With the marked differences to be observed between the early and late canes as detailed above, it should be possible with a little care to separate them at the mill, and it is suggested that an occasional analysis of the canes of different ages and stages in ripeness may be of use in getting the greatest amount of sugar out of the crop.



NATIVE CANE IN FLOWER, TUCUMAN, ARGENTINA.

THE 1919 TUCUMÁN SUGAR CROP.*

BY

W. E. CROSS.

FOR the harvest of 1919 in Tucumán there were some 183,000 acres of cane, of which some 160,500 acres were of the Java seedling varieties, principally POJ 36 and POJ 213, and 22,500 acres of the native cane (purple and striped) (Plates LIII and LIV). Of the entire extension of cane planted, 64·8 per cent. belonged to the factories and 35·2 per cent. to the independent cane growers. The total amount of cane produced was approximately 3,685,000 short tons, of which some 220,000 short tons were of the native cane, the rest being Java. The tonnage yield of the Java cane was thus around 21·5 short tons per acre, and that of the native cane around ten tons. The total amount of cane produced was not quite all ground as some 100,000 tons were left till next year and a small quantity was used for planting. The exact tonnage of cane which was worked up in the twenty-seven factories which operated was 3,555,329 short tons, the total amount of sugar produced being 271,286 short tons, not counting a small amount of hot room goods which will be purged in 1920. The average yield of sugar per hundred cane in the factories was thus 7·6 per cent.

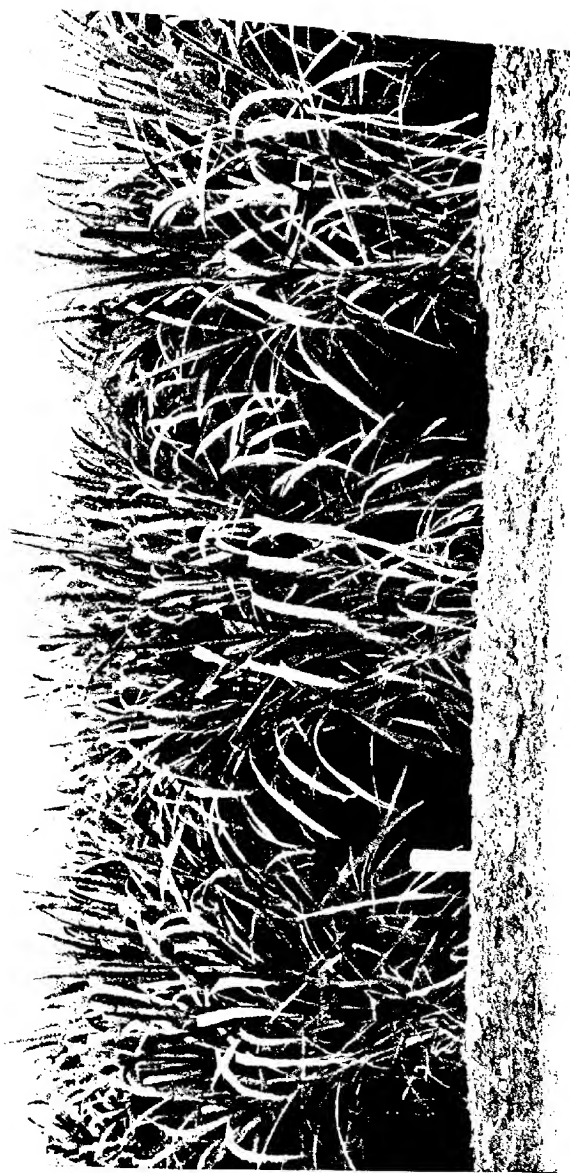
* Reprinted from *The Louisiana Planter and Sugar Manufacturer*, dated 5th June, 1920.

The amount of cane ground and the yields obtained in the various factories will be found in Table I.

TABLE I.

Factory				Cane ground (short tons)	Sugar produced (short tons)	Sugar produced % cane
Santa Ana	..	..	..	315,882	21,558	6.82
La Corona	..	..	..	189,781	13,702	7.22
La Trinidad	..	..	..	160,018	12,702	* 7.93
Mercedeo	..	..	..	166,858	12,241	7.33
La Florida	..	..	..	248,947	22,491	* 9.03
San Pablo	..	..	..	245,141	21,100	8.60
Concepcion of Lujan	..	..	..	395,650	31,619	7.99
Lastenia	..	..	..	141,050	11,875	8.41
Bella Vista	..	..	..	310,871	21,987	6.89
Nueva Baviera	..	..	..	108,135	10,361	* 9.58
El Paraíso	..	..	..	64,391	4,436	6.89
Esperanza	..	..	..	122,313	8,905	7.28
La Providencia	..	..	..	75,904	4,944	6.51
Los Ralos	..	..	..	133,423	10,543	7.90
San Juan	..	..	..	79,177	6,757	8.53
San Andres	..	..	..	100,149	7,699	* 7.68
Santa Rosa	..	..	..	54,789	3,391	6.19
San Josa	..	..	..	62,761	4,465	7.11
Santa Barbara	..	..	..	34,676	2,417	6.97
Santa Lucia	..	..	..	96,689	6,615	6.48
Cruz Alta	..	..	..	105,224	7,413	7.04
La Invernada	..	..	..	24,783	1,186	4.78
Amalia ..	..	..	..	90,566	6,961	7.68
Agullares	..	..	..	85,487	6,265	7.33
San Antonio	..	..	..	113,269	7,840	6.92
El Manantial	..	..	..	29,305	1,813	6.17
Total				3,555,329	271,286	7.63

* Raw sugar.



TYPICAL POJ 213 CANE IN TUCUMAN.

All the factories produced principally white sugar for direct consumption, except the four indicated by an asterisk in the Table.

Before going on to discuss the year's crop in its various aspects, it will perhaps be worth while to give the results obtained in previous years. Table II shows the cane production, and Table III the sugar production in the last ten years.

TABLE II.
Cane crop, 1909-1919.

Year	Total acreage (acres)	Total cane produced (short tons) *	Cane per acre (short tons)
1919	183,000	3,685,000	20.1
1918	180,000	1,819,044	10.1
1917	228,872	756,220	3.3
1916	160,283	973,810	6.1
1915	277,235	1,981,459	7.1
1914	263,709	3,276,575	12.4
1913	257,621	2,873,681	11.2
1912	224,483	1,964,330	8.8
1911	218,540	2,214,305	10.1
1910	209,273	1,675,488	8.0
1909	173,105	1,850,918	10.7

* Excluding the amount of cane used for planting.

TABLE III.

Year	No. of factories working	Sugar produced (short tons)	Sugar per acre (short tons)	Sugar extracted on 100 canes
1919	27	271,286	1.48	7.63
1918	26	95,765	0.53	5.26
1917	19	48,963	0.21	6.47
1916	21	49,143	0.31	5.05
1915	26	114,664	0.41	5.79
1914	28	307,387	1.17	9.38
1913	28	250,972	0.97	8.73
1912	27	134,306	0.60	6.84
1911	27	163,088	0.75	7.37
1910	27	128,791	0.62	7.69
1909	28	115,106	0.66	6.22

The very remarkable variations in the annual yields of cane and sugar per acre during the last ten years will be seen in these Tables, which give some idea of the really appalling crisis through which Tucumán has just passed. This crisis, as is perhaps known to

the reader, was due to the sudden and final degeneration of the Cheribon cane, which took place in the years 1915-17. The crisis forced the planters to accept the recommendation of the Experiment Station, to renew their entire plantations with the Java seedling varieties POJ 36 and POJ 213; and this they did so rapidly that in 1918 over 80 per cent. of the total cane harvested was of these varieties. This entire going over from the old standard cane to a new variety with which very few outside of the Experiment Station had any experience, indicates at once the courage and progressiveness of the Tucumán planter, and also incidentally his faith in the Experiment Station. The year 1918 was the first year when the industry was really based on the Java varieties and the grinding season of that year was looked forward to with great interest from the point of view as to whether the Java cane would or would not justify itself as a practical proposition, and what results it would give planted on a large commercial scale all over the province. Unfortunately, just after the first month of the crop, on the 8th of July, the province was visited by a frost of an entirely unprecedented degree, with minimum temperatures in parts of the cane belt as low as 14 degrees F., which created entirely abnormal conditions and made it necessary to defer final judgment on the value of the Java varieties until the following year. Nevertheless the frost itself served to bring out one property of these canes which in itself is enough to place them in a class by themselves: their remarkable resistance to the effects of low temperatures. While the native cane became almost worthless within a week or two of the big frost the Java plant cane was more resistant, and the Java stubble could be ground right on into September, although the terminal buds and almost all the other buds were killed on the 8th of July. Seeing that at least five-sixths of the cane in Tucumán is always stubble, this experience enables the planters to contemplate future frost years with a considerable amount of equanimity.

The year 1919, then, was the greatest year of the newly-adopted Java cane. Many people were sceptical about the possibility of obtaining results on a large scale, even approximating those reported by the Experiment Station, others about the high fibre content of the

canes, the ease of clarifying their juices, etc. It is, therefore, very satisfactory to report that the harvest represented an absolute vindication of the Java varieties, for with a much smaller acreage than was common with the native canes an absolutely record tonnage was produced, in average yield of cane per acre, 20.1 tons, and especially that of the Java cane, 21.5 tons, are results entirely without precedent in the local industry. Moreover the cane proved to be entirely satisfactory in the sugar-house, and gave an excellent average yield of sugar of 152.6 pounds per ton.

The very success of the Java cane, however, brought up some quite difficult problems for the industry, in respect of the excess of production of cane, and especially of the relation of the *canero*, or cane planter, to the industry. As we have seen, about two-thirds of the cane planted is in the hands of the factories themselves, the remaining one-third belonging to these *caneros*, who sell their cane to the factories. In years of cane scarcity, such as we have experienced since 1914, the cane of these growers was at a premium, but in 1919, with an over-production, the factories found themselves in a position to buy but very little cane, so that the *canero* was unable to sell more than a small portion of his product. To meet this situation the local government passed a law compensating the growers who could not sell their cane, from funds produced by a special tax on the sugar manufactured. The law allowed the *caneros* to dispose of their cane which they could not sell to the factories, for which therefore they received compensation, in any other way they could, the compensation being for the loss of the "principal market" of the product. The result of this was that some *caneros* decided to make the experiment, not previously made in this province on a large scale, of leaving the cane over without cutting until the next grinding season. The experiment was also made by a number of the factories, the total amount of all cane thus left over being some 100,000 tons. As the 1920 season has not yet commenced at this writing, the result of the experiments is not yet known, but from the analyses of many samples of the cane made in the Experiment Station it would appear to be in excellent condition for grinding.

The very large yield of cane in the fields, and the absence of killing frosts, made it obvious in the middle of the grinding season that the mills would have to work right on till November or December, or until the advent of the summer rains should make hauling impossible, and many factory owners feared that the cane would begin to diminish in sugar content with the daily increasing temperatures of the spring and early summer months. This especially so, as the cane, early in the grinding season, began to show a tendency to flower, and while this is a very rare thing in this country, it was understood from other parts that the cane after flowering would deteriorate rapidly. Fortunately these fears were not realized; for even though a small proportion of the cane actually did flower, on the average the sucrose content and purity was maintained right up to the end of the harvest. This result was another triumph for the Java cane.

The high fibre content constitutes one of the greatest differences between the old native cane and the Java varieties, for while the former shows only 10·5 per cent. fibre, the latter canes contain usually 12·5–13·5 per cent. In one way, of course, this has been a great boon to the industry, as the amount of auxiliary fuel needed by the factories working with the Java cane has been reduced very much thereby. On the other hand, the canes are much harder to grind, and the juice extraction much less than with the criolla canes. Before becoming accustomed to the new canes a number of factories lost time through breakages, but it is anticipated that these troubles will become fewer and fewer as the factories get used to this class of cane. Nevertheless, it must be admitted that the POJ 36 has a tendency to become very hard, and that this is considered somewhat as a defect in this variety by those factories whose milling plant is not of the most modern.

One of the most remarkable features of the Java varieties, from the Tucumán point of view at least, is their exceptional rapidity of deterioration after cutting. This property was studied by the Experiment Station years ago, and it was shown to be due to inverting enzymes which the canes contained at the moment of cutting and also elaborate after being cut. The result of this is that while

the native canes can be cut at the beginning of the week and milled at the end without any appreciable loss in purity, the Java varieties must be worked up within one or two days unless very serious losses in sugar are to be suffered. As has been said, this fact was more or less known to the factories when they began to work with the Java canes, but it needed bitter experience in some cases to make the fact "sink in." But even then losses were suffered by many *ingenios* by faulty organization of the harvest and haulage as well as owing to the great difficulties experienced in trying to ensure that the cane should arrive at the mills within a few hours after cutting. As time goes on, however, and the growers and even the labourers come to realize the great necessity of sending fresh cane to the mill, these difficulties will tend to disappear. As an example of the losses entailed, we may mention the case of one *ingenio* that was grinding with 70 per cent. purity, and on milling two wagons of freshly-cut cane from the same fields found the purity to be 84 per cent.

The Java cane was found to work up easily in the factory, no difficulties of clarification or boiling, etc., being experienced as long as fresh cane was being dealt with. The cane deteriorated by being cut several days, however, gives juices which sometimes are difficult to clarify.

As has been said, the predominating Java varieties planted in Tucumán are the POJ 36 and POJ 213. The other Javan varieties planted on a relatively small scale, the POJ 228, POJ 234 and the POJ 105, have not given such good results. The POJ 228 generally gives a lower tonnage than either the POJ 36 or the POJ 213, and has also shown itself to be much more susceptible to frost damage. It, however, has the advantage of suffering less from deterioration after cutting than the other canes. The POJ 234 was planted because of its property of early maturation and this property it has maintained on the large scale. However, it does not give a sufficiently large tonnage per acre to justify its preference to the other canes, as for early cutting better results can be obtained from POJ 213, topping it one or two joints lower than normal. The POJ 105, also called here *Ambar de Egipto*, has also failed to

justify itself, owing to its comparatively low tonnage, and its susceptibility to frost damage. Finally the Kavangire, which was also planted to some extent in the province, has proved inferior to the best Java canes, owing to its very late maturing, and also to the comparatively great expense of harvesting and shipping this very thin cane, and to its hardness for milling.

The POJ 36 and the POJ 213, on the other hand, as we have seen, have been absolutely vindicated during the record 1919 crop.

Very little damage was suffered during the year from insect and fungivorous pests, probably owing at least in part to the great resistance of the Javan varieties to these pests. The cane borer, which formerly seriously reduced the sugar production of the native cane, apparently finds the rind of the Java varieties too hard, as the number of perforated stalks was comparatively small. A small amount of mealy bug was noticed, but no damage was attributed to this cause. Of cane diseases, the mosaic disease is very common here in all the canes, but it does not appear to affect the yields seriously. The root disease, which has such a serious effect on the native cane, has not made great headway with the new varieties as yet. The disease called "toprot" was in evidence to a small extent, but did not do any great damage.

Finally, mention must be made of the excellent climatic conditions of the growing season 1918-19, which undoubtedly played their part in making the year 1919 a record one for Tucumán.

FARMYARD MANURE: ITS MAKING AND USE.*

Not many years ago it used to be the custom for certain representatives of agricultural science to extol the virtues of artificial manures, while farmers, on the other hand, stoutly maintained the superiority of farmyard manure. In recent years the position has changed. It is now the scientific worker who emphasizes the importance of farmyard manure and the need for making and storing it properly. Farmyard manure and artificial fertilizers do not compete with one another; they serve quite different purposes in the soil. No farmer can do without artificials, no matter how much farmyard manure he may have at his disposal, and, conversely, no arable farmer, except in a few special districts, would like to do without farmyard manure, even if he could have unlimited supplies of artificials at very low prices. The best results are always obtained on arable land by proper combinations of farmyard and artificial manures, although on grazing land farmyard manure may not act well.

So far as is at present known, the effects produced by farmyard manure in the soil are three:—

1. To supply nitrogen and potash to the plant.
2. To improve the physical condition of the soil, and thus increase its capacity for going into a good tilth and for holding water. The effect of this is to steady the yield.
3. To assist some of the micro-organisms of the soil; among other effects, to benefit the clover crop.

* Reprint (abridged) of a paper read by Dr. E. J. Russell, F.R.S., Director of Rothamsted Experimental Station, at a meeting of the Farmers' Club, 31st May, 1920, from the *Journal of the Ministry of Agriculture*, XXVII, No. 5.

On first of these is there any competition with artificial fertilizers, and even here the competition is restricted, because artificials usually exert their full action on the crop to which they are applied, while farmyard manure does not.

THE CONSTITUENTS OF FARMYARD MANURE.

1. *The excretions.* The animal excretions constitute an important part of the fertilizing material of farmyard manure. The urine is by far the most important—it is the chief source of the immediately beneficial part of the dung. The amount and value of the urine depend on the food and on the animal; urine contains the fertilizing constituents of all the digested food which has neither been retained in the animal nor secreted in the milk.

Its composition can be calculated, and this is done in determining the manurial value of foods, but the calculation never comes out quite right, because its valuable constituents are so easily decomposable that they are readily lost.

Although the dry matter of the urine forms only about 2 per cent. of the actual weight of the dung, it constitutes a much larger proportion of the weight of fertilizing materials. A ton of dung contains about 12 to 15 lb. of nitrogen, of which about 4 to 9 lb., according to the amount of cake and corn fed, would come from the urine.

2. *The litter.* Straw is by far the commonest litter, and it forms the chief part, by weight, of farmyard manure. Broadly speaking, one ton of straw makes four tons of farmyard manure but the additional three tons is very largely water, only a small part being other excretory substances. Of 100 parts of farmyard manure made in a bullock yard :—

75 are water.

About 2 are solid constituents of the solid excretions.

About 8 are constituents of the solid excretions.

About 15 are constituents of the litter.

On the basis of bulk, therefore, litter is more important than anything else, although not in other respects. Its chief effect

is that it forms the humus in the soil, and therefore helps to promote tilth and to improve the water-holding capacity. Unfortunately, its change into humus is expensive to the farmer in that the organisms effecting the change take up valuable nitrogen compounds from the urine that ought to have gone to feed the crop.

THE MAKING OF FARMYARD MANURE.

The simplest case is that of manure made from fattening bullocks in stalls or covered yard where the manure is of considerable value, and where pains are commonly taken to preserve it. Of every 100 lb. of nitrogen fed to the animals, about 95 lb. pass into the manure—often about 45 to 60 lb. in the liquid and 50 lb. to 35 lb. in the solid excretions. The 45–60 lb. are in a form highly valuable to the plant. The decomposition process, however, takes rather a heavy toll, in one way or another about 15 lb., leaving 30 to 45 lb. in a form really useful to the plant. The nitrogen in the solid, and such of this 15 lb. as is not altogether lost, may at some time become useful to the plant, but it does not count for much: only the 35 to 40 lb. balance can be relied upon to yield any profit.

When, as often happens, the manure is made in open yards, the loss becomes more serious. The minimum loss of 15 per cent. is exceeded, often much exceeded, and, as always, it falls on the most valuable part of the nitrogen. It is probably not far wrong to suppose that the manure from a bullock receiving 3 lb. of cake and upwards per day is worth 15s. or more per month when made in a covered yard, but not more than some 10s. or 12s. per month when made in an open yard. For a herd of twenty bullocks the loss in manurial value through having no roof to the yard may be any amount up to £5 per month.

It is often maintained, however, that some rain is necessary as otherwise the manure becomes too dry. While a certain amount of moistness is necessary, rain may seriously damage the manure by washing out some of its valuable constituents and by bringing about certain undesirable changes. It is probably better to keep rain away from the manure and to ensure sufficient moisture by

reducing the area over which the animals can wander, thus obtaining a high proportion of excretions among the litter. The comfort and well-being of the animals, however, must always be the first consideration. Periodically pumping liquid manure or water over the heap is not to be recommended.

STORAGE OF FARMYARD MANURE.

In the matter of storage the Northern farmer has some advantages over his colleagues in the South, one of which is that he can, as a rule, advantageously apply farmyard manure to his land in the spring. Manure made in the yards during winter can thus be hauled straight on to the land and ploughed in with reasonable certainty that this is the best thing to do. The Southern farmer, on the other hand, while he may be driven to spring applications of farmyard manure, would often obtain better results by applying the manure in the autumn. The storage of farmyard manure over the summer months thus becomes an important question.

However carefully matters are arranged, directly the manure is drawn from the yards some of its really useful nitrogen—the 30 lb. balance—begins to leak away. It forms part of the odour that gave the old farmers so much satisfaction. It enters largely into the black liquid, which, even in a well-conducted farm, is often seen draining away from the manure heap. Both smell and liquid are signs of leakage; but they do not represent the whole of the loss. It is wrong to suppose that matters can be put right by simply replacing the black liquid; its very existence is a symptom that bigger losses are taking place.

Many attempts have been made to obtain a reliable estimate of the amount thus lost. In experiments at Rothamsted the losses varied from 7 per cent. to 35 per cent. of the total nitrogen. A common loss was about 20 per cent., falling chiefly on the urine nitrogen. Assuming this latter figure were generally true—and we have no reason for supposing otherwise—our 30 lb. of valuable nitrogen would soon be reduced to little more than 10 lb., *i.e.*, 35 per cent. of the original nitrogen, or 75 per cent. of the most valuable portion, has disappeared.

LOSS IN FARMYARD MANURE.

It has often been suggested that kainit, gypsum, superphosphate or other substance added to the manure helps to reduce the loss by fixing ammonia. The processes bringing about the loss, however, are too complex to offer any reasonable expectation of the discovery of a satisfactory fixer.

It is difficult to form any estimate of the loss which occurs to farmyard manure over the whole country, but it must be considerable. Taking the present consumption of straw in the farm buildings of the United Kingdom to be about 10,000,000 tons per annum, the production of farmyard manure would be 40,000,000 tons, worth at present prices some £25,000,000 or more. The loss in making and storing the manure heap is not less, but probably more, than 20 per cent. of this, *i.e.*, more than £5,000,000 each year.

This loss cannot altogether be avoided, because it is part of the cost of the necessary decomposition of the straw, but it can be much reduced. In experiments at Rothamsted the provision of shelter to keep off some of the rain much increased the effectiveness of the heap.

Shelter can be provided in several ways. A layer of earth has proved effective, but it is not always convenient. Straw-thatched hurdles acted well in the trials. Placing the heap in a well-sheltered position is also helpful.

At present prices it is probably safe to suppose that an amount from 1s. to 5s. is added to the value of every ton of manure by providing shelter.

THE FEEDING OF CAKE.

There has been considerable discussion as to the extent to which cake-feeding adds to the value of farmyard manure. In recent experiments the additional value due to the cake was less than was expected, and the benefit of the cake was shown only in the first year, and not afterwards. The practical man, however, holds fast to cake-fed dung, and recent experiments at Rothamsted have shown a direction in which it may be superior to ordinary dung. The breaking up of the litter to form humus is brought

about by organisms which require the sort of nitrogen compounds that they would find in cake-fed dung; they would, therefore, be able to work more vigorously in cake-fed dung than in ordinary dung, and hence would tend to produce better soil conditions.

The evidence indicates that cake-feeding produces less benefit than might be expected on soils where plant food only is needed, but more benefit on soils where additional humus is necessary.

COW MANURE.

The question of cow manure is complicated by the necessity for satisfying sanitary inspectors, and by the fact that it is of poorer quality than bullock manure.

The poverty of cow manure arises from the fact that a cow secretes a considerable proportion of this nitrogen of the digested food in the milk instead of passing all of it into the urine like bullock. The urine is, therefore, weaker than in the case of bullocks, and there is a corresponding reduction in the value of the manure.

On some of the Oxfordshire farms a big covered shed is built next the cattle-shed for the storage of manure. The principle is sound, but the plan is sometimes inconvenient in execution. In Cheshire one sees good dungsteads—roofs of corrugated iron carried on stout posts, and so placed that the dung can easily be tipped underneath and then compacted. These are of great value, but care must be taken that the manure is sufficiently well compacted to prevent it becoming too dry.

Cow manure, however, presents an interesting possibility, because so much of the liquid is or can be collected separately, and this should certainly be done wherever practicable. The liquid is very valuable, containing as a rule about 18 lb. to 23 lb. of nitrogen per 1,000 gallons, besides possessing a high potash value.

A suitable dressing is 1,500 gallons per acre, and it serves excellently for seeds and as a spring application for winter oats or winter wheat. On an average each cow contributes about $1\frac{1}{4}$ gallons

of urine per day,* which is worth about 2s. 6d. per month. The difficulty at present is to apply this material.

ARTIFICIAL FARMYARD MANURE.

As the bulk of farmyard manure is litter, and the valuable part of the residue is largely made up of liquid excretions, it is not difficult for the scientific investigator to make an artificial farmyard manure from straw and artificial fertilizers. This has been done at Rothamsted, and one or two tons of the product were tried on the field. It is too early as yet to say whether the material will work out economically in practice, but the principle is sound; it consists in allowing the straw to decompose with formation of humus, and supplying the necessary nitrogen compound in the form of an ammonium salt. When the details are worked out the method may probably prove of interest in districts like the Rothings, in Essex, where quantities of straw are produced but no live stock is kept, and yet where farmyard manure ought to be used.

POSSIBILITIES OF IMPROVEMENT.

The possibilities of improving bullock manure lie in the following directions:—

1. To make it in a covered yard, having sufficient beasts to keep the manure moist.
2. To put it into the ground as soon as possible after the beasts are removed; but, if this is impossible, to make a tight clamp and provide some shelter by a layer of earth or by some other device.
3. To avoid washing by rain or exposure to weather.

The defects of the clamp, even when compacted and sheltered, are recognized, and science has not yet said the last word as to the storage of manure; but for the present it is the only practicable method.

The improvement of manure from cowsheds can be effected:—

1. By collecting the liquid separately in a cement tank.

* Both at Woking and at Garforth, however, Collins gives 5 gallons containing 4 lb. of dry matter as the figure for the North.

2. By storing the solid in a covered dungstead, to which can also be added manure from the horses. It is necessary to compact the heap. Provision must also be made for a tank to collect drainage.

The application of the liquid to the land, however, is a difficult problem. The method of distributing the liquid over the farm by means of pipes has been tried, but has resulted in financial loss. Something can be done by delivery from carts, but the most helpful line is the use of absorbents, which is now being investigated at Rothamsted. This is an important problem, and it will grow in importance if the soiling system of keeping dairy cows develops in this country.

RETTING FLAX IN WATER.*

SOME years ago attention was drawn to a method of retting flax in water inoculated with a pure bacterial culture. This method was described by Professor Giacomo Rossi, Director of the Institute of Agricultural Bacteriology in the Royal Higher School of Agriculture, Portici, Italy, in an article entitled "The Industrial Retting of Textile Plants by Microbiological Action," in the *International Review of the Science and Practice of Agriculture* (August 1916, 1067). The process depends on the action of a special aerobic bacillus, of which the prototype is *Bacillus Comesi*. In 1915 the Société Française de Rouissage Industriel was founded to work the Rossi patent, and a factory was erected at Bonnetable in the district of Mayers, Sarthe Department, France, where flax is now retted on a large scale.

At the request of Mr. Philippe Roy, Commissioner-General of Canada in France, a visit has been paid to the Bonnetable works by Mr. Alfred Renouard, a civil engineer, who has made careful observations of all the operations and the various stages of the process, and has prepared a report which has been published in the *Weekly Bulletin Department of Trade and Commerce, Commercial Intelligence Branch, Canada* (1919, XX, No. 803, p. 1185). The bacterial ferment employed in the Rossi method is an aerobic bacillus which is capable of consuming the pectinous matter in which the fibres are embedded, but does not attack the cellulose of which the fibres are composed. There is therefore no danger of the flax being injured if the normal time for the completion of the retting is exceeded.

The method consists essentially of three stages: (1) the immersion of the flax straw in water at 82-86° F. in suitable vats; (2) the addition of a certain quantity of a culture bouillon of the

* Reprinted from *The Bulletin of the Imp. Inst.*, XVII, No. 4.

bacillus; and (3) the passage of a current of air through the water in the vats during the whole of the retting period.

The cultures are supplied from Prof. Rossi's laboratory in tubes ready for use in the preparation of the bouillon. The vats are constructed of reinforced concrete, and each has a capacity of 50 cubic metres (about 50 tons of water) and is capable of dealing with 5-5½ tons of flax straw. At the bottom of the vat and on each side is a branched pipe provided with holes, these pipes being used for the admission of air. Along the bottom and down the middle of the vat is a perforated tube of larger size for the introduction of steam to warm the water. The water enters the vat through another pipe, each vat being thus supplied with three sets of pipes, each set being controlled by a separate valve, *i.e.*, one for the air, a second for the steam, and a third for the water.

The bundles of flax straw are laid flat in the vat and placed side by side until the vat is filled. Water is then introduced, the flax being held down by wooden strips as it tends to rise above the surface. Steam is introduced to raise the temperature of the water to 82-86° F., and the culture bouillon is then added. Air is now passed into the vat from an air compressor which delivers 200 litres of air per minute to each vat. The operation is completed in 36-40 hours.

The bundles of retted flax straw are removed from the vats and conveyed to the drying ground, where they are spread out on the grass. After a few days on the grass the flax is dry and ready to be subjected to the breaking process, but in the winter or during bad weather artificial drying must be practised. At the Bonnetable works, the artificial drying is effected by spreading the damp flax straw on racks in a specially constructed drying room, and submitting it to a powerful blast of hot air.

It is stated that the cost of equipping such a retting factory is comparatively small and the method of operating is very simple. The process is more economical than the so-called hot-water retting methods, and has the further advantage that no change of water is required during the operation. After the required temperature has been reached by the admission of steam, no further heating is

necessary, as the fermentation generates sufficient heat to maintain the temperature. The water which is run off from the vats after the retting is finished is of a pale yellowish colour and is almost free from odour.

After examining the different grades of flax produced at Bonnetable, Mr. Renouard considers that the Rossi process can furnish the best possible results from flax straw of any kind which may be treated. Moreover, as the process can be checked at any moment, the action can be so controlled as to give products answering to all the requirements of flax spinners. The yield of fibre amounts to about 20 per cent. of the weight of the flax straw.

It is mentioned that the Rossi retting process can also be applied to hemp and ramie, and that, according to tests made by Prof. Rossi, it appears that Sisal leaves when crushed and retted by this method furnish a good, white fibre of better quality than that produced in the usual way.

In connection with this microbiological retting of fibres, it may be mentioned that, according to the *International Review of the Science and Practice of Agriculture* (October 1917, 1417, and April 1919, 477), Carbone and Tombolato have isolated an anaerobic bacillus from the mud of some of the Bologna hemp retting pits, which has been termed *Bacillus felsineus* and is capable of retting hemp and other textile plants. This bacillus has been found not only in the mud of hemp pits in the province of Bologna, but has also been isolated from the mud of two retting pits of Rovigo and from certain retting products of the province of Naples, and it seems highly probable that it is the active agent in the retting of Italian hemp. In conjunction with *Saccharomyces*, the bacillus rets hemp stalks in less than 2½ days at a temperature of 98-99° F. and has been extensively tested in the Italian hemp districts. It has been shown by Carbone that *Bacillus felsineus* is capable not only of retting hemp, but also of retting flax, ramie, nettle, *Eurcræa*, *Sansevieria*, *Agave* and many other plants. It always produces a very rapid retting and furnishes fine, white, well-separated fibres.

A NEW THEORY OF THE ORIGIN OF SEA ISLAND COTTON.*

SEA ISLAND COTTON is generally considered to have originated from the West Indian perennial cotton (*Gossypium barbadense*).

At a meeting of the Manchester Literary and Philosophical Society held in 1830, Mr. John Kennedy, one of the two founders of the present firm of McConnel & Co., Ltd., read a letter (from which an extract is given below), which had appeared previously in the *Charlestown Courier* (South Carolina).

The writer of the letter (Thomas Spalding of Darien, Georgia) states as follows: "The Sea Island cotton was introduced directly from the Bahama Islands into Georgia. The seed, as I have been often informed by respectable gentlemen from the Bahamas, was in the first instance procured from a small island in the West Indies, celebrated for its cotton, called Anguilla. The winter of 1786 brought several parcels of cotton seed from the Bahamas to Georgia; among them (in distinct remembrance upon my mind) was a parcel to the Governor Tatnall of Georgia, from a near relative of his, then Surveyor-General of the Bahamas, and another parcel at the same time was transmitted by Colonel Roger Veisall, of Exuma, who was among the first, if not the first successful growers of cotton, to my father Mr. James Spalding, then residing on St. Simon's Island, Georgia. I know my father planted his cotton seed in the spring of 1787, upon the banks of a small rice field on St. Simon's Island. The land was rich and warm, the cotton grew large and blossomed, but did not ripen to fruit; it, however, ratooned or grew from the roots the following year. The difficulty was now over; the cotton adapted itself to the climate, and every successive year from 1787 saw the long staple cotton extending itself along the shores of Georgia and into South Carolina."

* Reprinted from *The Agricultural News*, Barbados, Vol. XIX, No. 468.

During the progress of investigations, on the mode of inheritance of characters in cotton, certain facts have come to hand which throw considerable light on the way in which Sea Island cotton probably originated.

Briefly, the facts suggest that Sea Island cotton originated from a natural cross between a glabrous broad-leaved West Indian Native, with botanical affinities to *G. brasiliense*, and some variety of American Upland.

We may accept, as substantially correct, the statement of Spalding that the original Sea Island cotton seed came from Anguilla *via* the Bahamas. In what characters does Sea Island cotton differ from indigenous West Indian Native, and by what means were the new characters acquired? It will, perhaps, be convenient to summarize the salient differences between Sea Island, Upland, and West Indian Native in tabular form:—

	Sea Island	Upland	West Indian Native
Habit	Sympodial	Sympodial	Monopodial
Resistance to leaf-blister mite	Susceptible	Susceptible	Practically immune
Resistance to cotton worm .. .. .	..	..	Comparatively resistant
Leaf	Glabrous	Hairy	Glabrous
Petal spot	Present	Absent	Present or absent
Pits in boll	Sunken	Superficial	Sunken
Boll loculi	3-4	3-5	2-4
Lint	40-55 m.	20-25 m.	30-35 m.
Seed	Black with green tuft	Woolly	Black with green tuft

It will be seen that while Sea Island cotton resembles the coarse-leaved West Indian Native in many of its characters, it differs from it in being extraordinarily susceptible to the attacks of leaf-blister mite and cotton worm, and in its annual or sympodial habit—all of which characters are possessed by Upland cottons. Planted anywhere in the West Indies, and left to itself, Sea Island cotton could certainly not maintain itself. It would certainly succumb to the prevailing climatic conditions and to infestation with leaf-blister mite. Its behaviour is that characteristic of an exotic plant.

Experiments have shown that all West Indian Native cottons breed true to the monopodial habit, *i.e.*, all nodes on the main axis, up to about thirty, produce only vegetative branches. The combination of monopodial habit with great vegetative vigour confers on these types their perennial character. Furthermore, Sea Island cotton breeds true to the sympodial habit, the first fruiting branch being put forth at nodes 8-14. In thousands of plants of both Native and Sea Island cottons there has never been the slightest tendency observed for the Native to develop the sympodial, or for Sea Island to take on the perennial habit. It may be remarked at this point that experiments were carried on in Barbados for many years, which had for their object the production, by gradual selection, of Sea Island from Native. Needless to say, these experiments were doomed to failure from the very outset. Selection by itself will not change perennial cotton into annual.

When the monopodial Native is crossed with the sympodial Sea Island, or Upland, the F_1 generation is sympodial. This was found to be the case in Leake's experiments with the corresponding morphological forms found in Asiatic cottons.

In the second generation segregation occurs into monopodial and sympodial, though there is no strict line of demarcation. The majority of the plants, however, are sympodial and annual in habit, and breed true to this character in this generation cultures.

Only about one plant in 300 is really monopodial. In a cross between a coarse-leaved, glabrous West Indian Native and Upland, the first generation plants were, morphologically, almost indistinguishable from Sea Island. They possessed the sympodial habit and susceptibility to leaf-blister mite of the Upland, combined with those morphological characters of the West Indian type which cause it to resemble Sea Island. In addition to this, the lint was over 40 mm. in length, and exceedingly fine and silky in texture, thus closely approaching Sea Island in character.

In the second generation several plants were noted possessing the same general likeness to Sea Island.

We may thus hypothetically reconstruct what happened when West Indian Native seed was introduced into the United States.

The first year of growth showed nothing but perennial (monopodial) plants which did not arrive at maturity. If we postulate natural crossing to have taken place when they flowered the following year between these types and neighbouring Upland cottons, the natural hybrids, being early maturing and long-linted, would attract immediate attention, and the seeds from them would be carefully preserved and planted. Once the sympodial habit was acquired selection of the most promising plants could quite conceivably have resulted in the development of the Sea Island variety as it is at present constituted.

While this hypothesis has more intrinsic probability as an explanation of the origin of Sea Island cotton than any other theory yet advanced, it must be admitted that the actual reconstruction of Sea Island cotton by this means has not been accomplished in recent practice. It must be borne in mind, however, that there exist many different strains of West Indian Native which agree in being broad-leaved, glabrous, tufted-seeded, etc., but differ in other respects. The synthesis of Sea Island cotton could probably only be effected as a result of the segregation of some rare gametic combination derived from a cross between a special form of West Indian Native and perhaps also a special form of Upland.

Notes

NATALITE.

IN South Africa pioneer work has been done in the production of motor fuel known as Natalite by distillation of the molasses from the sugarcane. It is by no means a perfect fuel for internal combustion engines and the difficulty so far has been to discover a powerful denaturant that is both cheap and plentiful. In 1919, the Advisory Board of Industry and Science recommended that the manufacturers of Natalite should be given permission to manufacture a certain quantity of the spirit, using one per cent. of pyridine as a substitute for the costly wood naphtha then used. But this recommendation was not accepted. The "Industrial South Africa" now reports that in recent months a new denaturant has been found in a petroleum product known as Simonsen and the authorities have permitted its use in the place of wood naphtha. It is stated that this product is very efficacious and its presence with pyridine in industrial alcohol fully meets the desired end. In view of the urgent need for the production in large quantities of cheap motor spirit this discovery is of considerable interest. [WYNNE SAYER.]

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GOAT'S RUMEN FOR DIALYSIS.

WITH the taking up of the work on protein by the Agricultural Chemist to the Government of the United Provinces, much difficulty was experienced in dialysis on account of shortage in the supply of parchment.

Our idea, therefore, was to find out something indigenous that could advantageously be used at the present abnormal time.

Trials were made with the bladders of different animals, but these too did not prove satisfactory. Some of these were ridiculously small, while others were found unsuitable for extensive trials owing to religious susceptibility of the laboratory servants and to difficulties in obtaining them.

Working with the different parts of a goat's skin the idea struck me that a trial should be made with the rumen.

Most encouraging results were obtained with the preliminary tests.

Goats' rumina are plentiful in India and could be had in any number from butchers at a cost of only about an anna each.

Preparation of these for dialysis, as has been described below, does not present any extraordinary difficulty. Some of these are big enough to hold a single charge of more than five litres of liquid; moreover, they act very quickly. In actual work, soluble salts begin to pass out within a few seconds. When running water is used, practically all saline matter is got rid of in about 12 hours.

Too much care cannot be taken to keep the thing perfectly sterile during the whole process.

Preparation. The rumina as obtained from the butchers are carefully cleaned and thoroughly washed. Air is next pumped in through the oesophageal orifice which is then carefully tied with a piece of string, and the rumina, in the inflated condition, are hung up in the sun for several hours to dry. When perfectly dry, air is driven out, and the rumina are soaked in milk of lime (prepared from best lime obtainable) and kept immersed in it, with occasional turning over, from 8 to 10 days. These are then taken out, thoroughly washed and carefully scraped with a blunt spatula. These are then again thoroughly washed and soaked for two days in a 0.5 per cent. acetic acid solution. The acid is then washed out and the rumina are fit for use as dialysers. [S. C. BANERJEE.]

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PROSPECTS OF THE WORLD'S SUGAR MARKET.

THE "Hamb Borsen-Halle," of June 25th, 1920, contains a most interesting survey of the position and prospects of the world's sugar

market, from which we quote as follows : All over the world there is, as heretofore, still to be noted a great demand for sugar which is very far from meeting with anything like an adequate supply. In those countries where the authorities have fixed the prices, the latter have been subjected of late to a further increase or a considerable increase of the prices is in contemplation in regard to the new crops. While in the countries where the sugar trade had been released from control, the prices have, as a natural result of the great preponderance of demand over supply, likewise gone up to a large extent.

During the first years of the war, the tremendous falling-off in the beet-sugar production in Europe was to some extent compensated for by an increased production of Colonial cane sugar. But as recently as last month it was found necessary once again to reduce the estimates of Colonial cane sugar; from the end of last year, by which time the production had been estimated at $245\frac{1}{4}$ mill. zentner, it had to be reduced by not less than $11\frac{1}{4}$ mill. zentner, thus showing the estimate to amount to merely 234 mill. zentner. In this way the hope of at least partly counterbalancing the great falling off of the beet-sugar production has disappeared, especially as it would appear that the latter, too, has been greatly overestimated, and the figures as estimated at the end of last year would, according to the revised returns, have to be reduced by exactly 18 mill. zentner, so that one would have to count the estimated beet-sugar production as merely 69 mill. zentner.

By a remarkable coincidence, both in regard to beet as well as cane-sugar production, it was the two most important countries—Germany and Cuba—which were mostly responsible for the necessity of revising the figures of the estimated sugar crops, which only a few months ago seemed perfectly justified. The causes which contributed to these regrettable disappointments are to be found, as regards Germany and the other European countries concerned, in the abnormal weather conditions of last autumn, the continued coal famine, and, last but not least, the lack, as a result of the political unrest, of skilled labour and the reduced productivity. In Cuba, too, the weather conditions did not come up to expectations, and

labour troubles also came into play here. At any rate, it may justly be assumed that from the very beginning, whether for speculative reasons or otherwise, a considerable overestimate of the probable cane-sugar production has taken place.

However it may, it appears that the trading year ending 31st August, 1919-20, has proved disappointing all along the line, and instead of relieving the general sugar shortage it has rendered it still more difficult, as will be seen from the following figures (these were produced in million zentners):—

	1919-20	1918-19	1917-18
Beet sugar in Europe	55.75	74.75	84.85
Beet sugar in America	13.35	13.35	13.90
Total production of beet sugar ..	69.10	88.10	98.75
Total production of cane sugar (including Spain)	234.15	239.50	246.30
Total world production	303.25	327.60	345.05

Even though the above figures still but represent estimates and cannot claim to be regarded, nor should be regarded, as exact, nevertheless, they graphically depict the general position of the world's sugar supply during the years following the official conclusion of the world war. Demand and supply exceed the production by innumerable million zentners, and under these circumstances sugar is likely to remain for some years to come a rare product, and, as compared with the pre-war low prices, will be extraordinarily dear, even when the exchange in the various countries will gradually have reassumed normal conditions. [*Production and Export*, July 1920.]

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THE USE OF TRASH IN THE CULTIVATION OF RATOON CANES.

EXPERIMENTS to test the value of piling the trash on the banks between rows of ratoon canes have been carried out on a plantation in Hawaii, the results of which are reported in "Facts about Sugar," January 24, 1920.

In one experiment two varieties of cane were treated, namely, H. 109 and D. 1135, both as second ratoons.

Immediately after the cane was cut, the trash was piled around the stool, and not covered with soil in any way. In the no-trash control plots the trash was removed completely. In all other respects the plots received identical treatment.

As a result both varieties of cane produced less cane and less sugar from the trashed plots. The difference in sugar was caused, not by any very great difference in weight of cane produced, but by a distinct difference in the quality of the juice. In all cases the juices from the trashed plots were poorer than those from the no-trashed plots.

From these results it would seem that trash, when not buried, is not as valuable as had been supposed, at least under Hawaiian conditions where irrigation is extensively employed. Under such conditions the particular value of trashing cane fields as recognized in West Indian cane cultivation would be minimized. The value of the trash piled on the rows, as is the usual custom in the West Indies, is that of a mulch for conserving soil moisture and keeping down the growth of weeds. As a fertilizer its value is not great. [*Agricultural News*, dated April 3, 1920.]

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SEED-RATE OF SUGARCANE.

WHEN one talks of agricultural improvement to an average cultivator the latter at once takes it to mean greater production and an increased yield per acre. But a higher gross return does not always result in an increased net profit, as the latter very much depends on the initial outlay. To reduce the cost of cultivation without in any way sacrificing the outturn and to obtain a heavier yield without in any way materially increasing the cost of cultivation, do form the two chief methods of increasing the net returns from any crop. It is intended in this short article to show how the former way is possible and practicable in the case of one item in sugarcane cultivation, viz., seed rate.

Sugarcane is one of the most important irrigated crops of the Bombay Presidency and with the opening of new canals its cultivation is extending rapidly. The local system of cultivating it is too costly and too wasteful of labour and capital and very often not sufficiently paying. The new Manjri method is a distinct advance on the local system in point of economy of labour and capital required, as bullock power can to a large extent be substituted for manual labour and the operations done more economically and in time.

Seed-rate is one of the costly items in cane cultivation, and in years following a severe drought enough sets are difficult to obtain, and even if available do sell at abnormally high rates, as was the case in the last planting season. Thus any saving effected in this connection is useful.

The local practice is to plant 16,000 to 18,000 sets per acre; in some cases sets from whole canes are used and in others only the top sets; the seed-rate, however, being the same in both cases. The sets from an average *Pundia* cane are usually each about one foot in length (each set possessing 3 eye-buds). Thus when they are planted end to end, as is usually done, as many sets are required as there are linear feet in the rows to be planted. In the local method cane is planted in furrows two and a half feet apart, and thus the total linear length of the rows in one acre is 17,424 feet, demanding on an average 16 to 18 thousand sets per acre, a slightly heavier or smaller seed-rate being used according to the length of the sets. When the new Manjri method was introduced, the distance between two rows was doubled and hence the linear length of rows of cane actually planted came to be only 8,712 feet. If sets are planted end to end, only 8,000 to 9,000 sets would suffice for an acre, which would be half of that used formerly. Thus cultivators were in the beginning rather shy to take up this method and its seed-rate, and even when some did so they followed everything but the seed-rate, the tendency being always towards a heavier one. The experience at Manjri for the last five years has, however, proved beyond all doubt that the reduced seed-rate does not at all adversely affect the tonnage.

But this fact suggested a series of experiments to determine the optimum seed-rate for *Pundia* cane in medium black soils of the Deccan and the conclusions drawn below are mostly based on work done in 1917-18 and given on page 25 of Bulletin No. 90 of the Department of Agriculture, Bombay Presidency, and quoted below in part for ready reference.

Statement.

Year	No. of sets per acre	No. of eye-buds per acre	No. of shoots germinated per acre	No. of plants on 2-8-17	Tillers produced	Ratio of plants after tillering to plants germinated	No. of canes obtained per acre	Tillers which matured	Percentage of tillers matured	Ratio of mature plants to germination	Weight of canes per acre	Weight per cane	Weight of <i>gut</i> per acre	No. of canes per eye
17-18	6,000	18,000	8,660	37,765	29,205	4.4	25,935	17,375	59.4	3.0	99,617	3.8	142,78	1.3
17-18	9,000	27,000	13,500	40,830	27,630	3.9	22,302	9,222	33.0	1.7	100,785	4.5	13,582	0.4
17-18	12,000	36,000	20,880	39,245	18,365	1.9	23,971	3,091	16.8	1.1	98,134	4.1	13,907	0.1

The following remarks on the statement are tentative until further data are available. Yet the figures are very illustrative. The seed-rates tried were 6,000, 9,000, and 12,000 sets per acre. The germination obtained was 47.5, 48.9, 58.0 per cent. respectively, giving thus an original stand of sprouts at 0.98, 1.5, and 2.4, respectively, per linear foot in the three cases. This shows that there was a distinct start in favour of the heavier seed-rates. The cultivator usually believes that a heavy stand at start means a heavy outturn in the end; we shall see if facts bear this supposition out.

It is the natural tendency of cane to produce underground branches or tillers as they are usually called. This characteristic is more marked with some and less in other varieties, generally the thin and reed-like varieties tillering more profusely than the thick types. The local cane, *viz.*, *Pundia*, is, however, a heavy tillerer and, given proper conditions of space, aeration and soil-moisture and heat, it is not uncommon to count 25 to 30 canes in one stool. In the reduction of seed-rate it is this factor that is taken advantage

of, the aim being to put in the minimum seed-rate and secure the maximum number of mature canes.

Tillers begin to appear after about six weeks from the date of planting and the process goes on up to about August, when the main growth shades the ground and crowds out any tillers that may try to come up.

The counting in August gave per linear foot a stand of 4.3, 5.6 and 4.5 shoots, respectively, and thus improved the original start by 3.35, 4.1 and 2.1, respectively, in the three cases, the smaller seed-rate of 6,000 sets having had more tillers than that of 12,000. In fact "suckering depends largely upon the room, the greater the distance apart the greater the number of suckers."

Of these if we calculate how many did actually develop into mature canes (supposing that all the mother sprouts grew into ripe canes), we find a larger percentage of these with the less seed-rate, there being a complete growth of 59.4, 33.0 and 16.8 per cent., respectively.

Following the matter further it will be seen that, at the time of harvest, for every linear foot the three seed-rates gave 2.97, 2.52, and 2.75 number of canes. The weights of individual canes were on an average 3.8 lb., 4.5 lb., and 4.09 lb., respectively, i.e., the yield in cane per linear foot in the row was 11.32 lb., 11.52 lb., and 11.25 lb. in the three cases, the tonnage varying in the same proportion. The small variation in the outturn is well within experimental error.

It is possible to estimate a general principle from the above data. With an original stand of one shoot per linear foot in rows opened five feet apart, the outturn obtained is satisfactory, and thus it would be enough if a germination of 8.712 eye-buds is secured per acre. Taking the average germination of 70 per cent., and making allowance for the eye-buds that fail to germinate, a seed-rate of 12,445 buds or 4,148 sets of three eye-buds each should suffice for an acre. Experiments are in hand at the Manjri Farm in that direction and a seed-rate of 4,500 sets per acre is being tried.

This reduction in the seed-rate would mean a saving over the local seed-rate of at least Rs. 58 per acre at Rs. 5 per thousand sets,

a rate common in normal years, or Rs. 140-6-0 or more at the rates current in the last planting season of 1920.

Then why is a heavier seed-rate put in by the cultivator? The first reason is his diffidence in the final outturn; secondly, the local method of planting in beds having furrows only 30 inches apart uses up a large seed-rate; thirdly, the absence of selection of sets from the top third of canes only, the lower part of cane giving always a very poor germination (see Mr. Mahajan's article in the *Poona Agricultural College Magazine*, Vol. VII, No. 2, page 93); fourthly, improper planting of sets without seeing whether the eye-buds are all placed to sides brings down the germination figure considerably (see Leaflet No. 8 of 1915, of the Bombay Agricultural Department); fifthly, improper tillage and bad irrigation which retard and often-times seriously affect the germination; sixthly, the planting is often much delayed by the cultivators up to late in summer when the cane-borer is active and kills many of the shoots and thus reduces the number of useful sprouts.

If proper care is taken in the selection, planting, and after-care of the sets and the planting done in the proper season, a good germination of at least 70 per cent. may easily be secured. [V. S. Kulkarni in the *Poona Agric. College Magazine*, Vol. XI, No. 4.]

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TREATMENT OF WOUNDS ON TREES.

THE "Journal of the Jamaica Agricultural Society," December 1919, has a note on the treatment of the wounds made after pruning trees. There are many different preparations which have been recommended in different parts of the world for dressing the cut surfaces made in pruning trees. The wood of these wounds, if left untreated, especially in the case of trees with soft wood, like that of cacao, easily decays, and affords entrance to insect and other pests. The Supervising Agricultural Instructor, Mr. Cradwick, in a long experience in Jamaica, has found that common gas tar is the best and by far the cheapest preparation for the purpose. But it must be used properly, not merely daubed on, but painted on and rubbed well in, as if polishing a piece of furniture. The wound is thus

made water-proof and disinfected. [*Agricultural News*, dated April 3, 1920.]

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NEW IMPLEMENTS AT THE ROYAL SHOW.

THERE is no longer any question that the British farming community, which has in the past always been considered so retrogressive, is now being converted whole-heartedly to the more general employment of machinery for all purposes in connection with cultivation. Nothing was more striking in the Royal Show (the 79th of its type which was recently held at Darlington) than the great interest that was shown in the large numbers of new types and classes of machinery designed essentially for labour saving and for more intensive cultivation. It is not surprising to find a fair number of tractors exhibited, since these are becoming more and more popular among farmers through the whole world, and these are mostly similar to those which were entered for the trials at Lincoln. Several examples of Fordson's were to be seen as well as Austin's, these two being perhaps the most popular classes in use, probably owing to their relatively low price. The Blackstone tractor was of special interest, as it is the only type which will run directly on kerosine, all the others having to start on petrol. This is accomplished by having a compressed air self-starter, and another feature of interest in this machine as well as in that known as the Martin, built by the Martin Cultivator Co., of Stamford, is that chain track construction is adopted.

Many of the leading American tractors were to be seen besides the Fordson and some of them are listed at a very reasonable price. For instance, the Emerson with a 20 h.p. motor is sold at £495, whilst the Titan is £437 and the International £280. One of the best known and most successful British tractors is the Sanderson, built at Bedford, and fitted with a 25 h.p. engine, having three speeds forward and a reverse. It has one or two specially useful features including a winding drum, whilst the provision of a tool box in front of the radiator forms a protection, which is specially useful when the

tractor is driven by an unskilled man. Needless to say, these machines are arranged to act as stationary engines when required, driving any of the usual classes of farm machinery or, if necessary, centrifugal pumps, dynamos, etc. Even the Fordson, which is the cheapest tractor to be obtained, has provision for this work, being fitted with a detachable pulley. A new and apparently useful self-contained motor plough is exhibited by John Fowler and Co., fitted with a small two-cylinder engine, the total price being £360. This is, however, only a light machine and must not be compared with some of the more heavily built tractors. It is interesting to note that the well-known pump manufacturing firm, Worthington Simpson, Ltd., are now building a motor driven tractor, but it was not completed in time to be exhibited at the Show.

Another well-known firm to enter this field of construction is Peter Brotherhood, Ltd., who show for the first time a powerful heavily built tractor fitted with a new engine of 35 h.p. of the four cylinder electric ignition type with cylinders $4\frac{3}{4}$ inches bore and $5\frac{1}{2}$ inches stroke, and running at about 900 r.p.m. This is quite novel and is worth describing in detail. Instead of the ordinary side by side valves, overhead valves are fitted as in some types of 1920 motor cars operated by means of long vertical push rods. The pistons are made of aluminium which is entirely new for such work, although it is being more and more adopted in internal combustion engines for other purposes, and the motor is designed to start on petrol and run continuously on kerosine. The only criticism one can make is that the engine looks too high class for its work. All the parts are totally enclosed, a cover being fitted over the overhead valves, and the ball bearings are used throughout. There is no doubt this is an excellent machine, but its price is probably high. It weighs about $2\frac{1}{4}$ tons and has a draw bar pull on high gear of 2,800 lb.

In view of the increasing use to which stationary oil engines are now being put on farms and plantations, it was not surprising that several of the latest designs were exhibited. Perhaps the most interesting were the Blackstone and the Crossley engines, both of the horizontal types with all the new features which were brought out by these two firms a short time ago. Both engines start up from

cold without any previous heating and will run on the heaviest oil with a fuel consumption of about half a pound per b.h.p. hour. The Blackstone engine shown is one 75 h.p., whilst the Crossley set develops 40 h.p. and there is little question that this class of motor will become increasingly popular for ordinary stationary work.

As a contrast the Vickers Petters semi-Diesel vertical engine represented quite a different type, two of 35 h.p. being exhibited of the latest design. Another exhibit of considerable interest by Petters was a series of their Petter Junior two-stroke oil engines which are specially adapted for use in India in connection with pumping and lighting sets being built in sizes up to about 8 b.h.p. and running on paraffin. An application of one of the smaller sizes—a 2½ h.p. set—which should be of considerable interest in India is its use for driving a very heavy roller. The drive is taken through a belt and the roller can be controlled very simply and easily, a wheel being fitted for steering whilst there is also a foot brake and a belt lever for use when starting and reversing. Another motor driven roller very useful for road and similar purposes is the Barford and Perkins which has already been used in India. Two types are available, one weighing 12 and the other 10 tons when empty, whilst in addition two tons of water ballast can be added. They are driven by means of ordinary electric ignition motors started on petrol and running on paraffin.

One of the greatest novelties was an entirely new motor windlass system for ploughing and cultivating which has been brought out by J. and H. McLaren, Ltd., of Leeds. It is designed essentially for cultivating areas of moderate dimensions. The principle is new as the machine consists of a four cylinder engine, the power from which is taken to a large windlass mounted on the chassis. The machine itself remains stationary during operation and draws the plough or cultivator over the land, which method, it is claimed, gives a higher efficiency than with the ordinary system of motor tractors or self-contained motor ploughs. The machine is mounted on four wheels and can be used for ordinary traction if required. It looks a powerful, well-built plant and the motor is, of course, provided with the usual belt pulley for driving other machines when needed.

A notable feature of the Show was the enormous space occupied by the Agricultural and General Engineers, Ltd., the combination of eleven of the largest agricultural and engineering firms which was effected a few months ago. This concern has just taken very large London show-rooms and headquarters in Kingsway, London, where the whole business will be centralized. It is thought that by this concentration on the commercial side very great economy will be effected and that, in the agricultural engineering industry, Great Britain, will, therefore, thus be enabled to meet any competition that may arise in the course of the next few years. [*Englishman*, dated 7th August, 1920.]

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COTTON GROWING IN MESOPOTAMIA.

IN view of the present scarcity in the supply of cotton, the attempts now being made to establish cotton growing on a large scale in Mesopotamia are of particular interest. Cotton has been grown in Mesopotamia from very ancient times and is still cultivated in small quantities by the Arabs in conjunction with food crops along the banks of both the Tigris and Euphrates. The fibre is used locally for spinning and as a stuffing material for pillows and mattresses. The country possesses a soil and climate favourable to the production of large yields of excellent cotton and in course of time it should add materially to the world's supply.

Since 1917 experiments have been conducted by an expert from the Indian Agricultural Service with a view to discovering the most suitable kinds to grow, and the results of the work done in this connection and the prospects of establishing a cotton growing industry are fully dealt with in the "Bulletin of the Imperial Institute," (Vol. XVIII, No. 1, January-March 1920). So far, American types of cotton seem to be the most suitable for cultivation in Mesopotamia. The members of a deputation of the British Cotton Growing Association, which visited the country towards the end of last year, were very favourably impressed with its possibilities for cotton production.

The acreage which will eventually be planted with cotton in Mesopotamia will depend on the quantity of labour available and the area on which a perennial supply of water can be guaranteed. It seems likely that a total of 150,000 to 200,000 acres could be cultivated annually by the existing population if the necessary facilities, in regard to agricultural machinery, transport, etc., were provided. At a low estimate this area should produce from 15 to 20 million pounds of cotton yearly.

**PERSONAL NOTES, APPOINTMENTS AND TRANSFERS,
MEETINGS AND CONFERENCES, ETC.**

WE are indebted to Mr. A. C. Dobbs, Director of Agriculture, Bihar and Orissa, and Mr. R. G. Kilby, C.I.E., I.C.S., District Magistrate and Collector, Darbhanga, for the note on the late Mr. Howlett appearing in this issue.

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MR. W. McRAE, M.A., B.Sc., F.L.S., Officiating Imperial Mycologist, Pusa, has been made substantive *pro tempore* in that appointment, *vice* Dr. E. J. Butler, M.B., F.L.S., on deputation, with effect from the 22nd September, 1920. Mr. McRae has also been appointed substantively *pro tempore* Joint Director of the Agricultural Research Institute, Pusa, from the same date.

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MR. M. WYNNE SAYER, B.A., Supernumerary Agriculturist, Pusa, has been appointed to officiate as Imperial Agriculturist, Pusa, during the absence on deputation of Mr. G. S. Henderson, N.D.A., N.D.D.

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MAJOR W. R. G. ATKINS, D.Sc., has been appointed Indigo Research Botanist in the Imperial Department of Agriculture in India, with effect from the 2nd October, 1920.

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MR. R. C. BROADFOOT, N.D.A., Superintendent, Central Farm, Coimbatore, has been appointed to act as Deputy Director of Agriculture, VI Circle, Madura.

MR. D. ANANDA RAO, B.Sc., Acting Professor of Agriculture, Agricultural College, Coimbatore, has been appointed Acting Professor of Agriculture and Acting Superintendent of Central Farm, Coimbatore.

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MR. F. T. T. NEWLAND, Government Agricultural Engineer, Madras, has been granted an extension of privilege leave for two months.

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MR. W. M. SCHUTTE, A.M.I. MECH.E., M.R.A.S.E., Agricultural Engineer to Government, Bombay, has been granted combined leave for three months. Mr. C. G. Paranjpe officiates.

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MR. A. D. MCGREGOR, M.R.C.V.S., Offg. Superintendent, Civil Veterinary Department, Bengal, has been granted combined leave for six months.

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MR. M. M. MACKENZIE, Superintendent of the Sipaya Farm, has been granted privilege leave for one month and seventeen days.

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CAPTAIN U. W. F. WALKER, on being appointed to the Indian Civil Veterinary Department, has been attached to the office of the Chief Superintendent, Civil Veterinary Department, Punjab, for training.

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MR. J. ST. C. SAUNDERS, I.C.S., has been appointed to hold charge of the offices of Director of Agriculture and Registrar of Co-operative Societies, Burma, as a temporary measure, during the absence, on combined leave, of Mr. C. R. P. Cooper, I.C.S., or until further orders.

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MR. C. J. N. CAMERON, M.R.C.V.S., D.V.H., Third Superintendent, Civil Veterinary Department, Burma, has been granted combined leave for one year, with effect from the 8th August, 1920.

MR. A. G. BIRT, B.Sc., Deputy Director of Agriculture, Assam, has been granted an extension of furlough for fourteen days from the 23rd October, 1920.

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MR. J. S. GAREWAL, M.R.C.V.S., has been appointed Superintendent, Civil Veterinary Department, North-West Frontier Province.

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THE Mycological, Entomological, Chemical and Bacteriological Sectional Meetings of the Board of Agriculture in India will be held at Pusa on the 7th February, 1921, and following days.

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THE eighth annual meeting of the Indian Science Congress will be held in Calcutta from 31st January to 5th February, 1921.

HIS EXCELLENCY THE RIGHT HONOURABLE THE EARL OF RONALDSHAY, G.C.I.E., Governor of Bengal, has consented to be Patron of the meeting, and the Hon'ble Sir Rajendra Nath Mookerjee, K.C.I.E., will be its President.

The Sectional Presidents will be :—

Agriculture and Applied Botany. Mr. S. Milligan, M.A., B.Sc., Agricultural Adviser to the Government of India, and Director, Agricultural Research Institute, Pusa.

Physics and Mathematics. Mr. J. H. Field, M.A., B.Sc., Director, Aerological Observatory, Agra.

Chemistry. Dr. H. E. Watson, Indian Institute of Science, Bangalore.

Botany. Professor Birbal Sahni, Punjab University, Lahore.

Zoology and Ethnography. Dr. F. H. Gravely, Superintendent, Government Central Museum, and Principal Librarian, Connemara Public Library, Madras.

Geology. Professor D. N. Wadia, M.A., B.Sc., Prince of Wales College, Jammu.

Medical Research. Lt.-Col. J. W. D. Megaw, M.B., I.M.S., Principal and Professor of Pathology, King George's Medical College, Lucknow.

Reviews

Cow-Keeping in India.—By ISA TWEED. Fourth Edition.
(Calcutta: Thacker, Spink & Co.) Price, Rs. 7-8.

THIS is a new edition of a well-known work largely relied on in the past by private owners of dairy cattle in India. The book does not pretend to deal with Indian dairying as an industry, but it gives sound practical advice and should be of assistance and interest to all concerned in dairy farming in this continent. After dealing briefly but accurately with the various breeds, or so-called breeds, of dairy cattle in India, the author goes on to give advice concerning the purchasing of cows, and follows with a chapter on the good points of a dairy cow. The next chapter deals with feeding, and here perhaps the author does not sufficiently impress on his or her readers the paramount importance in India of the growing of fodders specially suitable for milch cows. Compared with world conditions purchased fodder in India is invariably very expensive whereas the concentrates are comparatively cheap.

Chapter VI of the book deals with housing and utensils, and here the details given of buildings do not agree with the most modern ideas as to the design and construction of cow-sheds for large numbers of animals in India.

We do not at all agree with the recommendation in Chapter VIII that cows should be bathed once or twice a week in the hot weather and monthly in the cold season. The cow-owner in, say, Peshawar or Quetta, who attempted to bathe his cows in the middle of winter would, we think, only do so once.

In dealing with breeding bulls and bullocks, the author quotes various authorities and generally follows sound lines, and

the book is a really useful reference manual in regard to the serving of cows, barrenness in cows, determination of age of cattle, rearing of calves, castration of male stock and the treatment of cows during and after parturition.

A great deal of sound information is given concerning the composition and treatment of milk, cream, butter, *ghi* and native cheese on a small scale.

The work contains extracts from the published opinions of various so-called experts on dairy matters, some of which appear to have been written many years ago, and consequently are somewhat out of date in the light of current experience.

Book II is a store-house of useful information concerning the diagnosis and treatment of cattle diseases.

The illustrations are poor, being evidently reproduced from wood blocks. Surely the publishers could have given the public reproductions of photographs of actual animals in illustrating the various breeds. [Wm. S.]

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Charcoal as a Wonderful Fertilizer—By G. B. SET, B.A., F.R.H.S.,
Ivy Nursery Gardens, Calcutta.

THE author has found that the addition of charcoal to the soil greatly helps the germination of vegetable and flower seeds. Cuttings also strike very readily in a soil containing charcoal. Again, such plants as violets and chrysanthemums, which ordinarily do not thrive during the rains in Lower Bengal, continue to grow with astonishing rapidity when charcoal is mixed with the soil. Roses, geraniums, verbenas, lavenders, etc., are protected from the effects of heavy showers, and vegetables are found to grow with exceptional vigour, yielding crops larger in amount and better in quality when charcoal is present in the soil. In the case of winter annuals, the flowers appear earlier and possess more vivid colours. Similarly, fruit grafts are also much benefited when a moderate amount of charcoal is maintained in the soil.

The most interesting experiment conducted by the author was the one with a mango tree. This tree, while having a healthy and

widespread growth, used to bear a very poor crop of fruits. Various manures had been applied in previous years, but these had failed to produce any effect. When, however, the ground near the roots was dug up with special care to avoid injury to the primary roots, and the excavation filled up with manured soil mixed with charcoal, there was a marked improvement. A crop of 670 ripe mangoes was obtained as against 30, the average yield of the previous six years.

But while the experiments performed by Mr. Set are of great interest and deserve attention, the same cannot be said of the "explanations" advanced by him as to the function of charcoal in the soils. His arguments do not appear sound. For example, in accounting for the production of vividness of colours of flowers, he states that charcoal "possesses greater efficiency in carbon assimilation" and that "by a complete adsorption (*sic*) of sunlight, the transmission of the sun's full energy to the protoplasm is obvious and distinct."

In our opinion the beneficent action of charcoal is mainly to be attributed to the improvement brought about in the soil conditions. Charcoal rectifies the stiffness of clay soils and affords better drainage facilities. The aeration factor also is very largely modified on account of the porosity of the charcoal and its capacity to occlude large amounts of gases. Owing to the establishment of better sanitary conditions within the soil, healthier and more vigorous root growth ensues, resulting ultimately in an improvement of the whole plant system.

It is a hopeful sign that experienced horticulturists like Mr. Set are now taking up practical investigations on the subject of plant growth. [J. S.]

Correspondence

MANURING OF ORANGE PLANTS.

TO THE EDITOR,

The Agricultural Journal of India.

SIR,

IN Vol. XV, Part V (Sept. 1920), of the *Agricultural Journal of India*, pp. 511-513, Mr. K. P. Shrivastava, Offg. Economic Botanist, Central Provinces, describes a manurial experiment on orange trees.

It would greatly interest me and other readers if the author would give the following additional information :

(1) At what distance apart were the trees and lines of trees in the experiment ?

(2) Did each line get a separate manurial treatment ?

(3) What precautions were taken to ensure that the trees of one line were not being fed partly or wholly by the manure given to the adjacent line ?

COLLEGE OF AGRICULTURE, POONA :
Sept. 20, 1920.

Yours faithfully,

W. BURNS,
Economic Botanist to the
Govt. of Bombay.

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. General Botany for Universities and Colleges, by Prof. H. D. Densmore. Pp. xii + 459. (Boston and London: Ginn & Co.) Price, 12s. 6d. net.
2. Types and Breeds of Farm Animals, by Prof. C. S. Plumb. Revised Edition. Pp. viii + 820. (Boston and London: Ginn & Co.) Price, 16s. 6d. net.
3. Butter and Cheese, by C. W. Walker Tisdale and Jean Jones. (Pitman's Common Commodities and Industries.) Pp. ix + 142. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price, 2s. 6d. net.
4. The Sugar-Beet in America, by Prof. F. S. Harris. Pp. xviii + 342 + xxxii plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) Price, 12s. net.
5. Cytology with Special Reference to the Metazoan Nucleus, by W. E. Agar. Pp. xii + 224. (London: Macmillan & Co., Ltd.).
6. Industrial Alcohol, by Robert N. Tweedy. (Co-operative Reference Library, Dublin.) Price, 1s. net.
7. Forage Crops in Denmark. The Feeding Value of Roots, selected Strains of Roots and Grasses, Guarantees in the Trade of Seeds. Pp. 100. (London: Longmans Green.) Price, 6s. net.
8. Stories for the Nature Hour, compiled by Ada M. Skinner and Eleanor L. Skinner. Pp. 253. (London: George G. Harrap & Co.) Price, 5s. net.
9. A Manual of Elementary Zoology, by L. A. Borradaile. Third Edition. Pp. xviii + 616 + xxi plates. (London: Henry Frowde and Hodder and Stoughton.) Price, 18s.

10. Wild Creatures of Garden and Hedgerow, by Frances Pitt. Pp. ix+285. (London: Constable & Co.) Price, 12s. net.
11. A Handbook of Physics and Chemistry, by H. E. Corbin and A. M. Stewart. Fifth Edition. Pp. viii+496. (London: J. and A. Churchill.) Price, 15s. net.
12. Pyrometry, by Chas. R. Darling, F.I.C. Second Edition. (E. & F. N. Spin, Ltd., 57, Haymarket, London, S. W. 1.) Price, 10s. 6d. net.
13. The Manufacture of Alcohol from Molasses and Cane Juice, by J. Magne, Chemical Engineer, 36, Morgan Boulverad, New Orleans, La., U.S.A.
14. Grasses and Rushes and How to Identify them, by J. H. Crabtree. Pp. 64. (London: The Epworth Press, n.d.) Price, 1s. 9d. net.

The following publications have been issued by the Imperial Department of Agriculture since our last issue:—

Memoirs.

1. Some Aspects of the Indigo Industry in Bihar. Part I.—The Wilt Disease of Indigo. Part II.—The factors underlying the Seed Production and Growth of Java Indigo, by Albert Howard, C.I.E., M.A., and Gabrielle L. C. Howard, M.A., with the assistance of Chowdhury Ram Dhan Singh and Maulvi Abdur Rahman Khan. (Botanical Series, Vol. XI, No. 1.) Price, R. 1-2 or 2s.
2. New Indian Gall Midges (Diptera), by E. P. Felt, and Description of a Rhinocyphine Larva from Shillong, by Major F. C. Fraser, I.M.S. (Entomological Series, Vol. VII, Nos. 1 and 2.) Price, As. 12 or 1s. 6d.

**LIST OF AGRICULTURAL PUBLICATIONS IN
INDIA FROM THE 1st FEBRUARY
TO THE 31st JULY, 1920.**

No.	Title	Author	Where published
GENERAL AGRICULTURE			
1	<i>The Agricultural Journal of India</i> , Vol. XV, Parts II, III & IV. Price R. 1-8 or 2s. per part : annual subscription Rs. 6 or 9s. 6d.	Edited by the Agricultural Adviser to the Government of India.	Messrs. Thacker, Spink & Co., Calcutta.
2	<i>The Orange : A Trial of Stocks at Peshawar</i> . Pusa Agricultural Research Institute Bulletin No. 93. Price As. 6.	W. Robertson Brown, Agricultural Officer, North-West Frontier Province.	Government Printing India, Calcutta.
3	<i>Motor Tractors at Lincoln Trials</i> (free).	Issued from the Agricultural Research Institute, Pusa.	Ditto.
4	<i>Agricultural Statistics of India, 1917-18</i> . Vol. I. Price Rs. 2.	Issued by the Department of Statistics, India.	Ditto.
5	<i>Agricultural Statistics of British India, 1918-19</i> . Price As. 4.	Ditto. ..	Ditto.
6	<i>Report on the Production of Tea in India in the Calendar Year 1919</i> . Price As. 8.	Ditto. ..	Ditto.
7	<i>Estimates of Area and Yield of Principal Crops in India, 1918-19</i> . Price As. 8.	Ditto. ..	Ditto.
8	<i>Palm gul manufacture in the Bombay Presidency</i> . Bombay Department of Agriculture Bulletin No. 93. Price R. 1-3-9.	V. G. Gokhale, L. ag., Deputy Director of Agriculture, Konkan.	Yeravda Prison Press, Poona.
9	<i>Season and Crop Report of the Bombay Presidency for the year 1918-19</i> .	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay
10	<i>Cambodia Cotton</i> . Madras Department of Agriculture Leaflet No. 4 of 1920.	S. C. Sampson, B. sc., Deputy Director of Agriculture, V & VII Circles, Madras.	Government Madras Press,

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
<i>General Agriculture—contd.</i>			
11	Cultivation of Cambodia Cotton in Ceded Districts. Madras Department of Agriculture Leaflet No. 5 of 1920.	S. Ramasami Pillai, Assistant Director of Agriculture, II & III Circles, Madras.	Government Press, Madras.
12	Note on Sugarcane Cultivation for the use of the ryots in North Arcot, South Arcot and Chittore Districts. Madras Department of Agriculture Leaflet No. 6 of 1920.	J. Chelvaranga Raju Garu, Deputy Director of Agriculture, IV Circle, Madras.	Ditto.
13	Note on Tapioca Cultivation. Madras Department of Agriculture Leaflet No. 7 of 1920.	M. Govinda Kidavu, Assistant Director of Agriculture, VII Circle, Madras.	Ditto.
14	How to increase production of Crops. Madras Department of Agriculture Leaflet No. 9 of 1920.	D. Balkrishna Murthi Garu, Acting Deputy Director of Agriculture, I Circle, Madras.	Ditto.
15	Season and Crop Report of Bengal for the year 1919-20. Price R. 1-6.	Issued by the Department of Agriculture, Bengal.	The Bengal Secretariat Book Depot, Calcutta.
16	Agricultural Statistics of Bengal for 1918-19. Price R. 1-5 or 2s. 8d.	Issued by the Revenue Department of the Government of Bengal.	Ditto.
17	Season and Crop Report of Bihar and Orissa for 1919-1920. Price R. 1-2-0.	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
18	Agricultural Statistics of Bihar and Orissa for 1918-19. Price As. 14.	Ditto. ..	Ditto.
19	Agricultural Calendar for 1920-21 (in Burmese).	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
20	Cultivation of Potatoes, Burma Cultivator's Leaflet No. 53. (in Romanised Kachin).	F. Clerk, Assistant Superintendent, Htaw-gaw.	Ditto.
21	Seed Storage. Burma Cultivator's Leaflet No. 54.	E. Thompson, B. sc., Deputy Director of Agriculture, Northern Circle, Burma.	Ditto.
22	Cultivation of "Pesingon" (<i>Cajanus indicus</i>). Burma Cultivator's Leaflet No. 55.	Ditto. ..	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
<i>General Agriculture—contd.</i>			
23	(a) Minutes of a Conference of Officers of the Irrigation, Co-operative and Agricultural Departments held at Maymyo on the 16th April, 1920. (b) Sub-committee's Report on Water Measuring Experiments.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
24	Minutes of an Agricultural Conference held at Maymyo on the 17th April, 1920.	Ditto. ..	Ditto.
25	Minutes of an Agricultural Conference held at Maymyo on the 19th April, 1920.	Ditto. ..	Ditto.
26	<i>The Agricultural and Co-operative Gazette</i> (Monthly) from February to July 1920. Price As. 2 per copy.	Issued by the Department of Agriculture, Central Provinces.	Sholam Press, Nagpur.
27	Report of the Department of Agriculture, Assam, for the year ending 31st March, 1920.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
28	Tables of Agricultural Statistics of Assam for the year 1918-19.	Ditto. ..	Ditto.
29	Report of the Upper Shillong Agricultural Experiment Station for the year ending 31st March, 1920.	Ditto. ..	Ditto.
30	Report of the Kamrup Sugarcane Experiment Station for the year ending 31st March, 1920.	Ditto. ..	Ditto.
31	Report of the Fruit Experiment Station, Shillong, for the year ending 31st March, 1920.	Ditto. ..	Ditto.
32	Report of the Karimganj Agricultural Experiment Station for the year ending the 31st March, 1920.	Ditto. ..	Ditto.
33	Report of the Jorhat Agricultural Experiment Station for the year ending 31st March, 1920.	Ditto. ..	Ditto.
34	Cultivation of <i>dals</i> or pulses in the Assam Valley. Assam Department of Agriculture Leaflet No. 1 of 1920.	Ditto. ..	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
<i>General Agriculture—concl'd.</i>			
35	Cultivation of <i>dals</i> or pulses in the Surma Valley. Assam Department of Agriculture Leaflet No. 2 of 1920.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
36	Season and Crop Report of Assam for the year ending the 31st March, 1920. Price As. 8.	Ditto.	Ditto.
37	<i>The Journal of the Madras Agricultural Students' Union</i> (Monthly). Annual subscription Rs. 2.	Madras Agricultural Students' Union.	Literary Sun Press, Coimbatore.
38	<i>Quarterly Journal of the Indian Tea Association</i> . Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
39	<i>The Journal of Dairying and Dairy Farming in India</i> (Quarterly). Subscription Rs. 5 per annum including membership.	Published by the Indian Committee of the Dairy Education Association, Quetta.	Messrs. Thacker, Spink & Co., Calcutta.
40	<i>Journal of the Mysore Agricultural and Experimental Union</i> (Quarterly). Annual subscription Rs. 3.	Mysore Agricultural Experimental Union.	Bangalore Press, Bangalore.
41	<i>Poona Agricultural College Magazine</i> (Quarterly). Annual subscription Rs. 2.	College Magazine Committee, Poona.	Arya Bhushan Press, Poona.
BOTANY			
42	The Cultivation of Oranges and allied Fruits in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 95. Price As. 2½.	H. P. Paranjpe, B.A., Assistant Economic Botanist, Poona.	Yeravda Prison Press, Poona.
MYCOLOGY			
43	Budrot of Palmyra and Coconut Palms in Godavari and Kistna Districts. Madras Department of Agriculture Leaflet No. 8 of 1920.	Bhogappaya Sastri.	Government Press, Madras.
ENTOMOLOGY			
44	The Rice Leaf Hoppers (<i>Nephotettix bipunctatus</i> , Fabr. and <i>Nephotettix apicalis</i> , Motsch.). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 5. Price R. 1-8-0 or 3s.	C. S. Misra, B.A., First Assistant to the Imperial Entomologist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
<i>Entomology—concl.</i>			
45	<i>Lantana</i> Insects in India. Being the Report of an Inquiry into the efficiency of indigenous Insect Pests as a check on the spread of <i>Lantana</i> in India. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. V, No. 6. Price Rs. 2-4 or 4s. 6d.	Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., Entomological Assistant, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
46	(a) New Indian Midges (<i>Diptera</i>). Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 1. (b) Description of a Rhinocyphine larva from Shillong. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. VII, No. 2. Price As. 12 or 1s. 6d. (for both numbers bound together).	E. P. Felt, State Entomologist of New York, U. S. A. Major F. C. Fraser, I.M.S.	Ditto. Ditto.
47	The Sugarcane Borer and its Control. Bombay Department of Agriculture Bulletin No. 94. Price As. 4-3.	Ramrao S. Kasargode, L. Ag., Assistant Professor of Entomology, Agricultural College, Poona.	Yeravda Prison Press, Poona.
BACTERIOLOGY			
48	Studies on the Root Nodule Organism of the Leguminous Plants. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. I, No. 9. Price R. 1-4 or 2s. 6d.	N. V. Joshi, B.A., M.Sc., L.Ag., 1st Assistant to the Imperial Agricultural Bacteriologist.	Messrs. Thacker, Spink & Co., Calcutta.
VETERINARY			
49	<i>Syngamus laryngus</i> in Cattle and Buffaloes in India. Pusa Agricultural Research Institute Bulletin No. 92. Price As. 6.	A. L. Sheather, B.Sc., M.R.C.V.S., Director and 1st Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, and A. W. Shilston, M.R.C.V.S., Second Bacteriologist, Imperial Bacteriological Laboratory, Muktesar.	Government Printing India, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*concl'd.*

No.	Title	Author	Where published
<i>Veterinary—concl'd.</i>			
50	A Note on the Treatment of Surra in Camels by Intravenous Injections of Tartar Emetic. Pusa Agricultural Research Institute Bulletin No. 95. Price As. 2.	H. E. Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist, Sohawa, Punjab.	Government Printing India, Calcutta.
51	Annual Administration Report of the Bombay Veterinary College and Civil Veterinary Department in the Bombay Presidency (including Sind) 1918-19. Price As. 6 or 9d.	Issued by the Bombay Government in the General Department.	Government Central Press, Bombay.
52	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1919-20.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
53	Annual Report of the Camel Specialist for the years 1917-18 and 1918-19 (in one volume). Price As. 2.	Issued by the Department of Agriculture, Punjab.	Government Printing Punjab, Lahore.
54	Report of the Civil Veterinary Department, Assam, for the year 1919-20. Price As. 8 or 1s.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
55	Statistics compiled by the Government of India from the Report of the Provincial Veterinary Departments for the year 1918-19.	Issued by the Government of India in the Revenue and Agriculture Department.	Government Monotype Press, Simla.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

TO BE HAD FROM

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR,
and from the following Agents:—

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| (1) THACKER, SPINK & CO., CALCUTTA. | (7) THACKER & CO., LTD., BOMBAY. |
| (2) W. NEWMAN & CO., CALCUTTA. | (8) SUNDER PANDURANG, BOMBAY. |
| (3) RAI M. C. SARKAR BAHADUR & SONS, CALCUTTA. | (9) RAI SAHIB M. GULAB SINGH & SONS, LAHORE. |
| (4) HIGGINBOTHAMS, LTD., MADRAS. | (10) MANAGER, EDUCATIONAL BOOK DEPOT, NAGPUR. |
| (5) THOMPSON & CO., MADRAS. | |
| (6) D. B. TARAPOREVALA, SONS & CO., BOMBAY. | |

A complete list of the publications of the Imperial Department of Agriculture in India can be obtained on application from the Agricultural Adviser to the Government of India, Pusa, Bihar, or from any of the above-mentioned Agents.

These publications are:—

1. *The Agricultural Journal of India*. A Journal dealing with subjects connected with agricultural economics, field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, agricultural cattle, farm implements, and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India, and is issued once every two months or six times a year. *Annual Subscription*, Rs. 6 or 9r. 6d., including postage. Single copy, R. 1-8 or 2s.
2. Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist).
3. Annual Report on the Progress of Agriculture in India.
4. Proceedings of the Board of Agriculture in India.
5. Proceedings of Sectional Meetings of the Board of Agriculture.
6. Memoirs of the Imperial Department of Agriculture in India :
 - (a) Botanical Series.
 - (b) Chemical Series.
 - (c) Entomological Series.
 - (d) Bacteriological Series.
 - (e) Veterinary Series.
7. Bulletins issued by the Agricultural Research Institute, Pusa.
8. Books.

The following are the publications of the last two years:—

- Scientific Reports of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1917-18. Price, R. 1-4 or 2s.
- Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist), for the year 1918-19. Price, R. 1-4 or 2s.
- Report on the Progress of Agriculture in India for the year 1917-18. Price, R. 1-8 or 2s. 3d.
- Report on the Progress of Agriculture in India for the year 1918-19. Price, R. 1-8 or 2s. 3d.
- Proceedings of the Board of Agriculture in India, held at Pusa on the 1st December, 1919, and following days (with Appendices). Price, As. 12 or R. 3d.
- Proceedings of the Second Meeting of Mycological Workers in India, held at Pusa on the 20th February, 1919, and following days. Price, As. 11 or 1s.
- Proceedings of the First Meeting of Agricultural Chemists and Bacteriologists, held at Pusa on 24th February, 1919, and the following days. Price, R. 1 or 1s. 6d.

AGRICULTURAL PUBLICATIONS—(Ouncd.)

Proceedings of the First Meeting of Veterinary Officers in India, held at Lahore on 24th March, 1919, and following days (with Appendices). Price, As. 8 or 9d.

Proceedings of the Third Entomological Meeting, held at Pusa in February 1919. (*In press.*)

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

BOTANICAL SERIES

- Vol. X, No. I. The Rice Worm (*Tylenchus angustus*) and its Control, by E. J. BUTLER, M.B., F.L.S. Price, R. 1-4 or 2s.
- Vol. X, No. II. Studies in Indian Sugarcanes, No. 4. Tillering or Underground Branching, by C. A. BARBER, C.L.E., sc.D., F.L.S. Price, R. 4-4 or 7s.
- Vol. X, No. III. Studies in Indian Sugarcanes, No. 5. On testing the suitability of sugarcane varieties for different localities, by a system of measurements. Periodicity in the growth of the sugarcane, by C. A. BARBER, C.L.E., sc.D., F.L.S. Price, R. 1-12 or 3s.
- Vol. X, No. IV. A *Pythium* Disease of Ginger, Tobacco and Papaya, by L. S. SUBRAMANIAM. Price, R. 1-8 or 2s. 6d.
- Vol. X, No. V. Studies in the Pollination of Indian Crops, 1, by A. HOWARD, GABRIELLE L. C. HOWARD, and ABDUR RAHMAN KHAN. Price, R. 1-4 or 2s. 6d.
- Vol. X, No. VI. "Kumpta" Cotton and its Improvement, by G. L. KORTUR, B. Ag. Price, R. 1-12 or 3s.
- Vol. XI, No. I. Some Aspects of the Indigo Industry in Bihar. Part I. The Wilt Disease of Indigo. Part II. The factors underlying the seed production and growth of Java Indigo, by ALBERT HOWARD, C.L.E., M.A., and GABRIELLE L. C. HOWARD, M.A., with the assistance of CHOWDHARY RAMDHAN SINGH and MAULVI ABDUR RAHMAN KHAN. Price, R. 1-2 or 2s.
- Vol. XI, No. II. Studies in Diseases of the Jute Plant. (1) *Diplodia Corechori*, Syd., by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S. (*In the press.*)

CHEMICAL SERIES

- Vol. V, No. IV. Cholam (*A. Sorghum*) as a Substitute for Barley in Malting Operations, by B. VISWANATH, T. LAKSHMANA ROW, B.A., and P. A. RAGHUNATHASWAMI AYYANGAR, Dip. Ag. Price, As. 12 or 1s.
- Vol. V, No. V. The Phosphate Requirements of some Lower Burma Paddy Soils, by F. J. WARTH, M.Sc., B.Sc., and MAUNG PO SHIN. Price, R. 1-12 or 3s. 3d.
- Vol. V, No. VI. Absorption of Lime by Soils, by F. J. WARTH, M.Sc., B.Sc., and MAUNG PO SAW. Price, R. 1-2 or 2s.
- Vol. V, Nos. VII & VIII. The Gases of Swamp Rice Soils, V—A Methane-oxidizing Bacterium from Rice Soils, by P. A. SUBRAHMANYA AYYAR, B.A.; and The Gases of Swamp Rice Soils, VI—Carbon Dioxide and Hydrogen in relation to Rice Soils, by W. H. HARRISON, D.Sc. (*In the press.*)
- Vol. V, No. IX. The Retention of Soluble Phosphates in Calcareous and Non-calcareous Soils, by W. H. HARRISON, D.Sc., and SURENDRA LAL DAS, M.Sc. (*In the press.*)

ENTOMOLOGICAL SERIES

- Vol. V, No. V. The Rice Leaf-hoppers (*Nephotettix bipunctatus*, Fabr. and *Nephotettix oprialis*, Motsch.), by C. S. MISRA, B.A. Price, R. 1-7 or 3s.
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